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USER'S GUIDE FOR CREW CHIEF: A COMPUTER GRAPHICS SIMULATION OF AN AIRCRAFT MAINTENANCE TECHNICIAN (VERSION 1 — CD 20) (U)

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MAY 1988

PERIOD OF PERFORMANCE NOVEMBER 1984 - MAY 1988

Approved for public release; distribution is unlimited.

ARMSTRONG AEROSPACE MEDICAL RESEARCH LABORATORY
HUMAN SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
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88 12 12 005

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) UDR-TR-87-103	5. MONITORING ORGANIZATION REPORT NUMBER(S) AAMRL-TR-88-034
6a. NAME OF PERFORMING ORGANIZATION University of Dayton Research Institute 6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION AAMRL/HEG
6c. ADDRESS (City, State, and ZIP Code) 300 College Park Avenue Dayton, Ohio 45469-0001	7b. ADDRESS (City, State, and ZIP Code) Wright-Patterson Air Force Base, Ohio 45433-6573
8a. NAME OF FUNDING / SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER F33615-84-C-0519
8c. ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62202F; PROJECT NO. 7184; TASK NO 08; WORK UNIT ACCESSION NO. 41

11. TITLE (Include Security Classification)
User's Guide for CREW CHIEF: A Computer Graphics Simulation of an Aircraft Maintenance Technician (Version 1 - CD 20) (U)

12. PERSONAL AUTHOR(S)
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13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
User's Guide	FROM Nov 84 TO May 88	88 May 25	381

16. SUPPLEMENTARY NOTATION
*Workload and Ergonomics Branch
Human Engineering Division

17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Three-dimensional, anthropometric, man-model, Aircraft design, Computer simulation, Aircraft maintainability, Aircraft maintenance tools evaluation, Aircraft (see reverse)
23	02		

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This User's Guide describes the procedures for using the CREW CHIEF system of programs. The CREW CHIEF system of programs is a computer graphics simulation of the physical characteristics and capabilities of Air Force maintenance technicians. The system as it now exists operates interactively with the CADAM* (Computer Aided Design And Manufacturing) software package. The user should be knowledgeable in CADAM operations, as CADAM interactions are not included in this document.

The Guide includes an introduction to the technician model (man-model) and the conventions used to develop and analyze the interactions of the man-model's physical characteristics and capabilities with the elements of the work station. Keywords:

*CADAM is a registered trademark of CADAM, Inc., 1935 Buena Vista St., Burbank, CA 91504. Use of this term does not constitute an endorsement of the CADAM system.

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Joe W. McDaniel, Ph.D.	22b. TELEPHONE (Include Area Code) (513) 255-2558 22c. OFFICE SYMBOL AAMRL/HEG

DD Form 1473, JUN 86 Previous editions are obsolete. SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

Block 18 (continued): maintenance technician, Manual materials handling, Visibility, Interactive analyses, Computer-aided engineering, ~~CAE~~ ~~CAD/CAM, CADAM™~~

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SUMMARY

This User's Guide describes the procedures to operate the Harry G. Armstrong Aerospace Medical Research Laboratory's and the Air Force Human Resources Laboratory's CREW CHIEF system of programs. The CREW CHIEF system of programs is interactive with the CADAM* (Computer-graphics Aided Design And Manufacturing) software package, and therefore it is necessary that operators be qualified in the use of CADAM, as this document does not duplicate the CADAM operating instructions. CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

The CREW CHIEF system of programs provides for designers a tool for early identification of design-related maintainability problems by analyzing the interaction of maintenance technicians' physical capabilities and the design elements related to specific maintenance tasks. Historically, many of such maintainability problems have been found when the system design prevents timely and cost-efficient corrective action. Such problems are often passed to the logisticians to correct, or to endure, after the system has been delivered. Since maintenance accounts for approximately 35 percent of the total cost of a system during its years of use, early identification and correction of design-induced maintenance problems can result in significant cost savings.

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The CREW CHIEF program is not intended to provide solutions for all problems. For example, current military standards provide guidelines for locating components for ease of accessibility based upon such factors as frequency of maintenance actions required and the criticality of the sub-system concerned. Due to space constraints, the possible locations of sub-system components may be limited. The CREW CHIEF program will not create designs, but will allow the designer to evaluate the maintainability of a candidate design. The program will also allow the user to analyze the interaction of a maintenance technician with a system design, and will enable the user to evaluate limitations and capabilities in three main areas: physical accessibility, strength, and visibility.

PREFACE

This work was performed by the University of Dayton, 300 College Park, Dayton, Ohio 45469, under United States Air Force Contract F33615-84-C-0519, entitled "Techniques for Workplace and Maintenance Evaluation." The government work unit number for this contract is 71840831. Dr. J. W. McDaniel, of the Armstrong Aerospace Medical Research Laboratory's Workload Ergonomics Branch (AAMRL/HEG), is the contract monitor.

The purpose of the report is to provide a detailed guide for the user to operate the CADAM* version of the CREW CHIEF program. It does not document the theoretical approaches used in developing the programs. The introduction of the report (Section 1) gives general background of the concepts and development of the programs. Sections 2 through 8 provide details for using the CREW CHIEF programs, and Section 9 is a Quick Reference section for the seasoned user.

The authors would like to thank the following University of Dayton Research Institute (UDRI) staff members for their contributions: John Quinn, Robert Berlin, John Skuya, James Rothey, Jeff Meyer, Glenn Robbins, Van Thai, and Mary Lynne Kennedy.

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GLOSSARY OF TERMINOLOGY

Action	A description of the user's objective and necessary input to operate the program.
Azimuth	A horizontal direction of a point from a reference point measured from 0° at the reference direction clockwise through 360°.
Body Size	The 1st, 5th, 50th, 95th, and 99th percentiles for both male and female, based on the Air Force maintenance technician population.
CADPARM table	A CADAM* parameter table.
Connector	A device used on aircraft to mate parts to the electrical system or to provide attach/detach points in long electrical cables to accommodate maintenance. They typically have male and female components held together by lock rings.
CREW CHIEF	The system of computer programs entitled CREW CHIEF.
Crew Chief	The man-model generated by the CREW CHIEF system of programs.
Default Value	Any value initially set by the CREW CHIEF system of programs.
Drawing	Any user-generated display.
Elevation Angle	Angle from some object in the work space to the line of sight.
Enfleshment	The exterior mesh that represents the muscles and tissues of the man-model and also represents his/her clothing.
Ergonomics	Scientific study of the relationship between man and his working environment.
Example	One of several possible actions chosen to illustrate a particular function.

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Front Display	One of four types of display for the man-model; the front half of the wire-frame man-model as viewed from the designer's location at the graphics scope; display contains less clutter than the full wire-frame model, but can be used for limited visual interference.
Head Point of Vector	The point of application of a tool or connector.
Interactive	Immediate response to input. In interactive processing, an image can be modified or edited and the changes seen right away, as contrasted to "batch" processing in which the user must wait for results.
Key in	To input user-specified information via a keyboard.
Man-Model	Software-generated technician as he/she appears on the screen.
Macro Geometry Function Key	CADAM-supplied function which allows users to access their own programs.
Mechanical Work	The product of force and displacement.
Obstacle Avoidance	Check during a Reach Analysis to ensure that a man-model can perform a task with no interference between the workstation and the man-model's arms.
Percentile	A value in the range of a set of data which separates the range into two groups so that a given percentage of the measures lies below this value.
Platform	The surface which supports the man-model's body.
Point of Attachment	The point to which the man-model attaches a tool.
Position Reference Point	The posture-dependent point on the man-model which lies in the same plane as the platform.

GLOSSARY OF TERMINOLOGY (CONTINUED)

Profile Display	One of four types of display for the man-model; a profile view of the man-model as seen fron the designer's viewpoint at the graphics scope; the least cluttered of displays, and provides a two-dimensional display suitable for "finished" plots.
Prompt	A short phrase on screen which cues the user's actions.
Rectilinear	Consisting of or bounded by lines.
Reposition Display	One of four types of display for the man-model; this display is chosen when the intent is to manually reposition the man-model; similar to the three-dimensional wire-frame model, but includes extra dashed lines to aid in the repositioning process.
Result	Subsequent system response to a user's input.
Screen	Another name for cathode ray tube (CRT)
Select	To choose a menu item or an element from a screen.
Shelf	The surface onto which an object is lifted.
Strength, Dynamic	A measurement of strength with motion resulting in force or torque and also resulting in mechanical work.
Strength, Static	A measurement of strength without motion resulting in force or torque but not resulting in mechanical work.
Tail Point of Vector	The line defined by this point and the head point determines from which direction the tool will be applied.
Window	The illuminated area of a CRT

Wire Frame Display	One of four types of display for the man-model; a three-dimensional wire frame figure which may be rotated and moved using the appropriate CADAM Window (PFK 27) Functions; a type of enfleshment which may be used for visually identifying potential areas of interference between the man-model and the workplace design.
Workplace	Any drawing which represents the man-model's task area.

LIST OF ABBREVIATIONS

AAMRL	Armstrong Aerospace Medical Research Laboratory
AAMRL/HEG	Armstrong Aerospace Medical Research Laboratory's Workload and Ergonomics Branch
AFHRL	Air Force Human Research Laboratory
AFR	Air Force Regulation
AFSC	Air Force Specialty Codes
ANKB	Alphanumeric Keyboard
CAD	Computer Aided Design
CADAM*	Computer-graphics Aided Design and Manufacturing
<CR>	Carriage Return
LOS	Line-of-Sight
LRU	Line Replaceable Units
N/A	Not Applicable
PFK	Program Function Keyboard
UDRI	University of Dayton Research Institute
WPAFB	Wright-Patterson Air Force Base
2-D	Two-dimensional
3-D	Three-dimensional

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LIST OF FUNCTIONS

@ACCES	CREW CHIEF Accessibility Function
@CREW	CREW CHIEF Main Programs Menu
@CCGEN	CREW CHIEF Generation Function
@MMH	Materials Handling Analysis Function
@TSKAN	CREW CHIEF Task Analysis Function
@TOOL	Tool Analysis Function
CCINIT	CREW CHIEF Initialization Function
CONFIG	Current CREW CHIEF Data Function
CONNEC	Connector Analysis Function
HDORT	CREW CHIEF Head Orientation Function
INTFER	Interference Analysis Function
REGEN	CREW CHIEF Regeneration Function
REPOSN	CREW CHIEF Manual Repositioning Function
VISAN	Visibility Analysis Function
WRKENV	Work Envelope Analysis

SECTION 1

INTRODUCTION

Approximately 35 percent of the life-time cost of a military system is spent to maintain the system. Much of this cost can be avoided if, during the system's developmental stage, the interaction between the maintenance technician and the system design can be analyzed. Past practice has been to make these analyses by visual inspection of engineering drawings and detailed mock-ups of the system. The mock-up, using real people to analyze the interaction, has been the most beneficial method of identifying maintainability problems. The major problem with using mock-ups is that the design must be at a mature stage before a mock-up can be constructed. When the system is at a mature stage, changes to improve maintainability are often not made because of the costs and time delays involved in design change, modification of the mock-up, and the re-analysis of the technician and mock-up interactions.

Computer Aided Design (CAD) systems and computer models which graphically portray human physical characteristics and capabilities have reached the stage where it is possible to assess the interactions of systems and technicians at early stages of design development. The earliest possible identification of maintainability problems due to the poor interaction of the system and the technician should help reduce

the life-time maintenance cost of a system. Thus, the concept and development of CREW CHIEF is a logical step in the early identification of maintainability problems.

The CREW CHIEF system of programs is interfaced directly with the CAD data base, allowing the designer to evaluate three human factor areas against drawings in that CAD data base. This capability allows early identification of maintainability problems and reduces, and may eventually eliminate, the requirement for mock-ups.

Maintainability problems, as related to human factors, generally fall into three areas: Physical Accessibility, Strength, and Visibility. In the development of the CREW CHIEF system of programs, the following definitions of these human factors were used.

1. Physical accessibility: the interaction of body size, technician posture, tool size and working envelopes, location of the task object relative to adjacent or interfering components or structures, and task analysis.

2. Strength: the technician's ability to apply a specified torque, and/or to lift, position, lower, or remove an object to/from a design-specified location from the posture dictated by the working environment.

3. Visibility: the field of view of the technician relative to technician posture, location of the task object, and components and structures that may partially or wholly obscure the task location.

A maintainability problem may involve combinations of these three human factors. For example, a lack of visibility may aggravate a physical accessibility problem by making it more difficult to properly align and position a tool in a restricted working area.

Current military standards establish guidelines for placement of components for accessibility, based on such factors as item size, frequency of maintenance and/or failure, and criticality to system operation. Although the CREW CHIEF system of programs will not resolve the designer's dilemma in such areas, its ability to analyze alternative designs in the interest of maintainability can provide realistic data for design decisions.

The following sections contain a PROMPT, ACTION, EXAMPLE, RESULT format. The user is invited to follow the examples **exactly** to ensure the user's ease in learning efficient use of the CREW CHIEF system of programs. Section 9 of this User's Guide is provided as a Quick Reference for a user who has become familiar with the CREW CHIEF system of programs. This section is written in a PROMPT, ACTION, RESULT format, and includes all possible branches of each CREW CHIEF function. Note that pertinent parts of the prompts are underlined.

1.1 SYSTEM REQUIREMENTS

The CREW CHIEF system of programs is designed to interact with a few popular CAD/CAM software packages and their data bases. Therefore, CREW CHIEF runs on the same hardware used to run the CAD/CAM software. The version of CREW CHIEF described in the manual runs under software package CADAM*, Version 20.0.1, and requires the user to have both the 3-D Interactive Design and Manufacturing Module and the Geometry Interface Module.

The CREW CHIEF system of programs is interfaced directly to the CADAM software (through the Geometry Interface Module), and follows very closely the nomenclature and user interface methods employed by CADAM. Thus minimal training time is required for the experienced CADAM user to learn to use the CREW CHIEF program.

NOTE:

CADAM's interface with the CREW CHIEF system of programs does not constitute an endorsement of the CADAM system by the U.S. Air Force or its contractors.

The CREW CHIEF program was developed with the main menu under CADPARM table "@CREW". In the program as it was developed, this is CADPARM3. If the system has CADPARM3 already allocated, the user will have to call the main menu by entering **@CREW** on the Alphanumeric Keyboard (ANKB) and then depress the **YES/NO** function key. If CADPARM3 is not previously allocated, the main menu

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"@CREW" can be called by selecting **/CADPARM3/** from the CADAM bottom menu. Check with the systems manager for the appropriate procedure for a particular system. (See Reference 1.)

It is recommended that the version of CADAM being used with CREW CHIEF have its model size set to the maximum (32K), as some of the program's graphic representations require a significant amount of drawing space (8-10K). The maximum REGION size should be set to 2000K, due to CADAM's program structure.

When running CREW CHIEF, the use of a single scope version of CADAM is recommended, since all scopes in a particular region are "locked out" while a Macro Geometry function, hereinafter referred to simply as "function," is executing. Executing in a multiple-scope environment will result in loss of productivity by all users in the region. CADAM instructions have the information necessary to set up a single-scope version of CADAM.

1.2 MAN-MODEL GENERATION

The CREW CHIEF Initialization function generates the man-model display in the form of three-dimensional (3-D) CADAM lines which are placed into a CADAM SET named "Crew Chief."

To prevent corrupting the design drawing with unnecessary geometry, the man-model is not automatically made a part of the designer's drawing upon generation. All pertinent information concerning the man-model is automatically written to FORTRAN

files and accessed when performing analyses. If the user desires to have the man-model display as a part of the drawing for future reference, he/she must "SAVE" the geometry with CADAM procedures after the function has run.

1.3 WORKPLACE DESIGN

The CREW CHIEF system of programs assumes that workplaces consist of valid 3-D CADAM drawing elements. These include, but are not limited to, 3-D lines, splines, points, and surfaces. CADAM's MESH geometry is not used or supported by CREW CHIEF, since the current Geometry Interface Module does not allow full processing of these elements.

The length of execution time required for analysis depends on the size of the drawing on which the analysis is being done. Execution time can be minimized by "NO-SHOWING" CADAM elements that are outside the immediate work area of the CREW CHIEF man-model. This allows the program to bypass the processing of irrelevant data, e.g., when performing an Interference Analysis, the user can NO-SHOW those CADAM elements that clearly do not interfere with the man-model.

Since interactive Macro Geometry programs cannot process any drawing other than the current one, analysis of overlaid drawings will be performed only on the active drawing. Thus the user may need to change the active drawing if he/she wishes to analyze geometry contained in a non-active member of an overlay.

1.4 THE CREW CHIEF MAINTENANCE ANALYSIS PROGRAMS

The CREW CHIEF Main Programs consist of five distinct functions: **Generation Functions, Maintenance Task Analysis, Visibility Analysis, Accessibility Analysis, and the** Current **CREW CHIEF Data (Configuration) (Figure 1.1).**

The first step in performing any analysis under CREW CHIEF is to retrieve a **CADAM** 3-D **drawing containing the design to be** analyzed. **Once the drawing has been retrieved, the user proceeds** to the CREW CHIEF **system of programs by depressing the Macro** Geometry **Program function key (PFK 11). (See Figure 1.2.)** Depressing **Macro Geometry calls the main menu, found in the** CADPARM Table "@CREW." **It is called by entering @CREW on the** ANKB and then depressing the **YES/NO** function key, or by selecting **/CADPARM3/** from the CADAM bottom menu. The user should check with his/her systems manager for the procedure to use with a particular system.

Once the @CREW table is called, the user is presented with the CREW CHIEF Main menu (see Figure 1.3). This menu contains the five main functions. The CREW CHIEF Initialization function (CCINIT) must be selected prior to using any of the other four major functions. To use any other function, select the abbreviation containing that function.

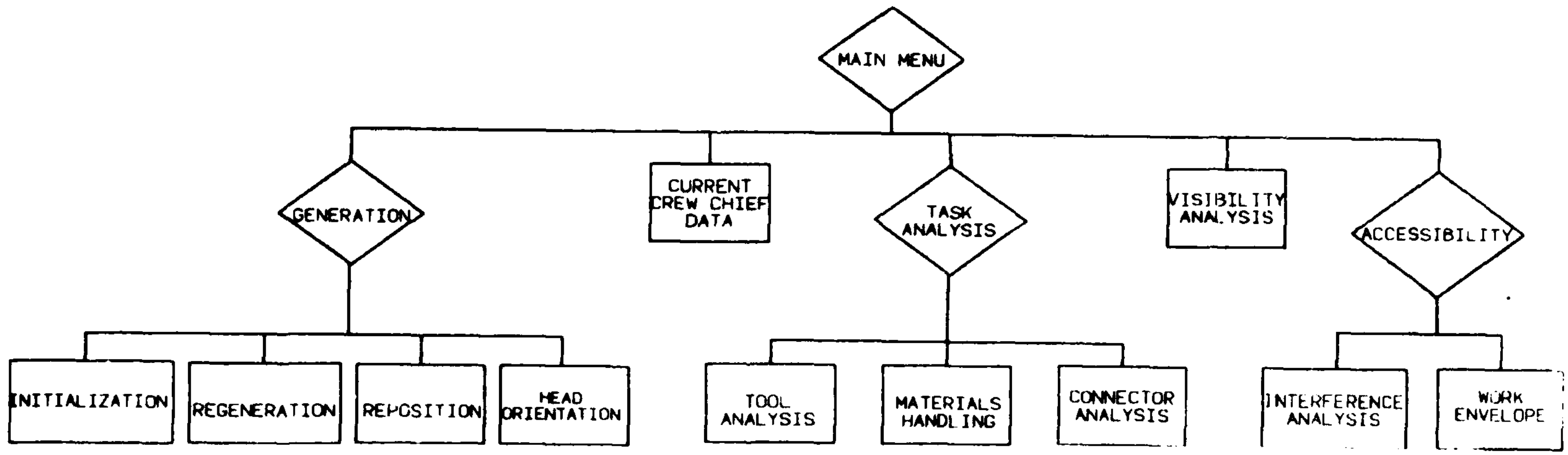


Figure 1.1. CREW CHIEF Programs.

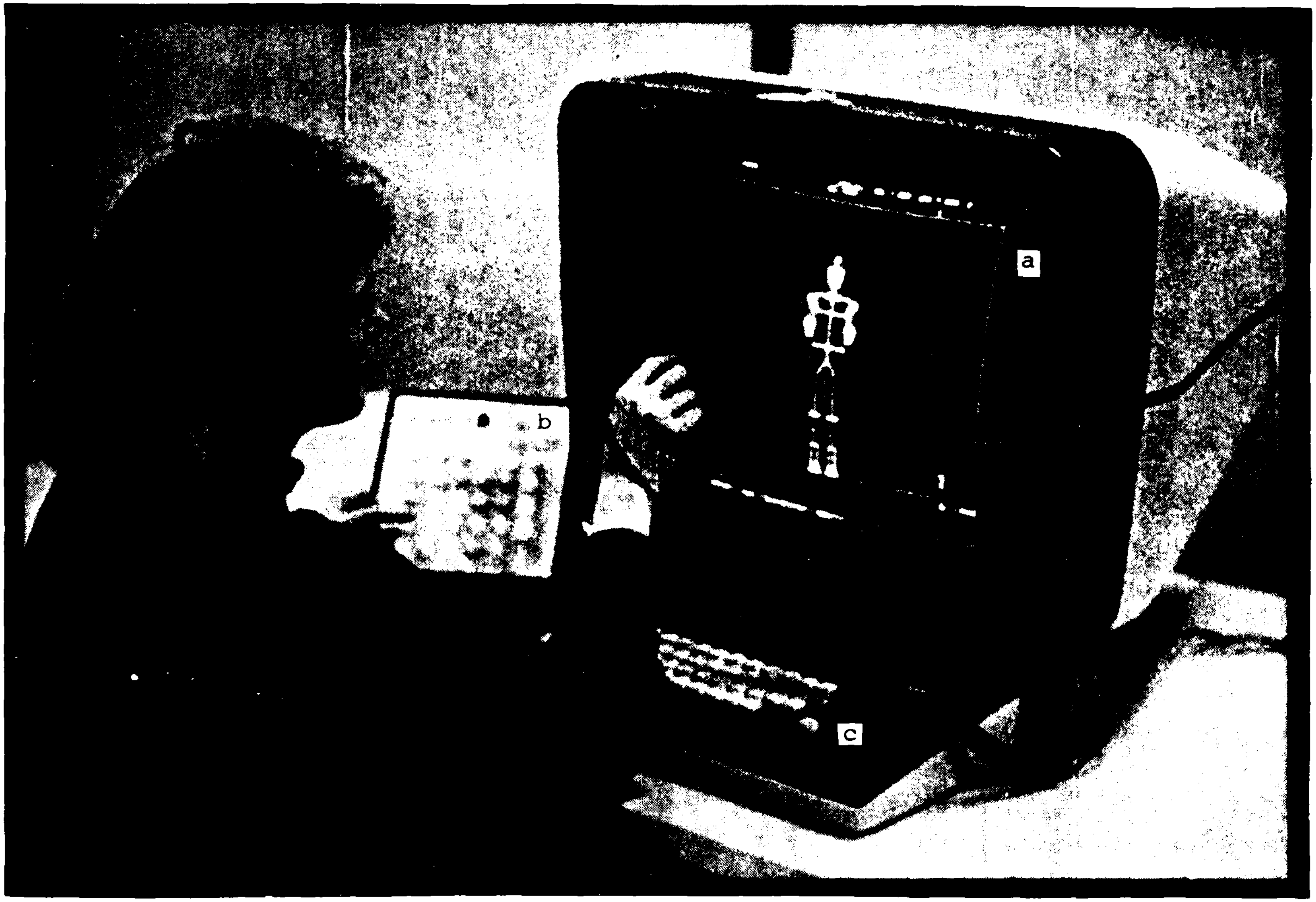


Figure 1.2. CRT Screen (a), Function Keyboard (b), and Alphanumeric Keyboard (c). The Operator Depresses the Macro Geometry Program Function Key and Uses a Light Pen to Select a Point.

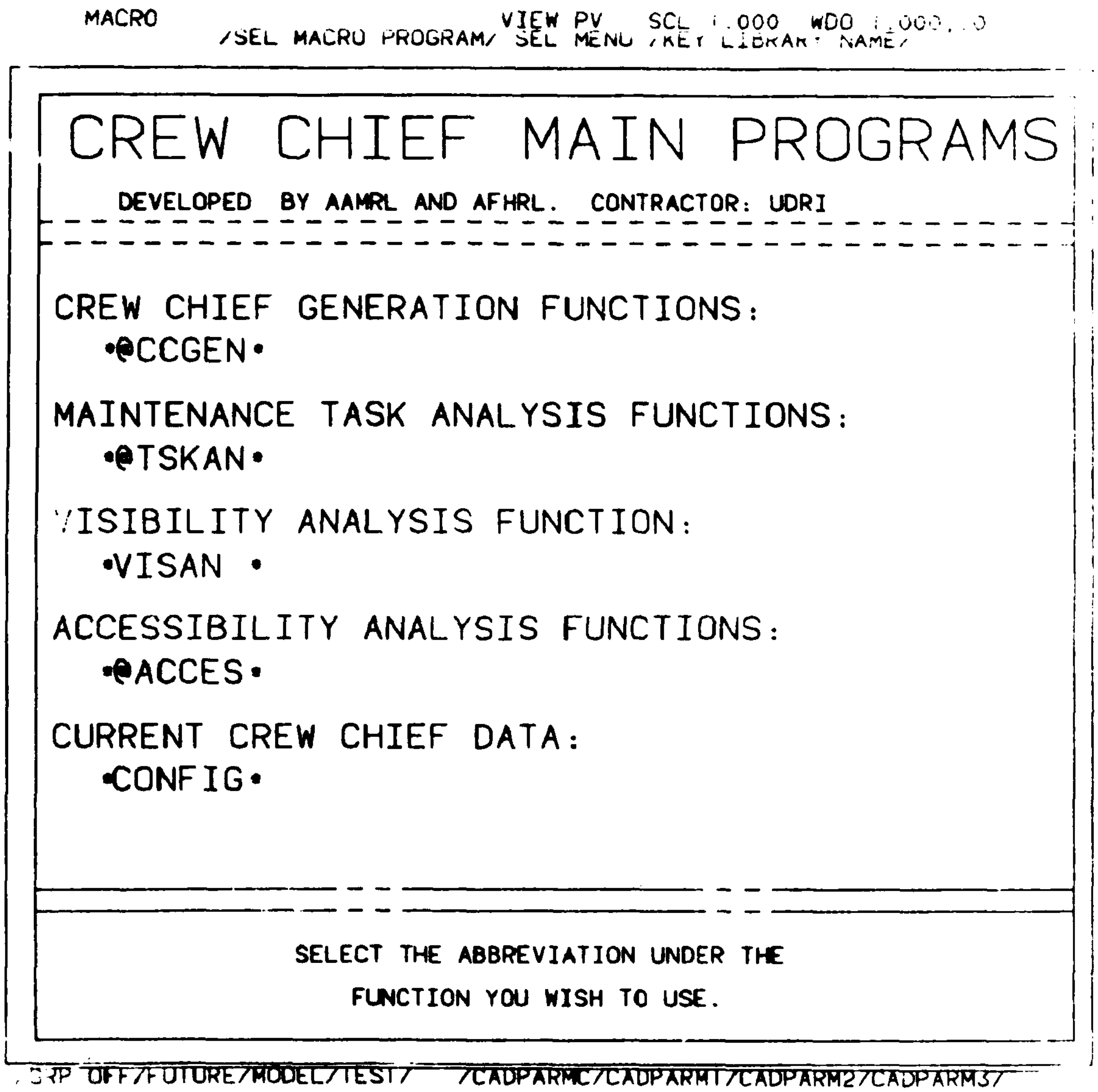


Figure 1.3. Menu for CREW CHIEF Main Programs.

1.5 GETTING STARTED

Since the CREW CHIEF and CADAM programs are interactive, there are basically three initial requirements to get started: (1) access the CADAM programs, (2) retrieve a 3-D drawing from the CADAM drawing files, and (3) call the CREW CHIEF system of programs. The basic steps to meet these requirements follow.

Step 1:

ACTION: Key in **SUBMIT 'CREW.CHIEF.CNTL(RUNCCF)'** on alphanumeric keyboard (ANKB)

RESULT: The first prompt appears.

Step 2:

PROMPT: COLD START

WARM START (prompt appears in bottom third of window)

ACTION: Select **COLD START**

RESULT: Screen display area is blank and a new prompt appears.

Step 3:

PROMPT: KEY GROUP, USER

ACTION: Key in user's group and sub-group ID

<CR>

RESULT: Screen display area is blank. FILES appears in upper left-hand corner of window.

GROUP = and USER = appear in upper right-hand corner, and a new prompt and menu appears.

Step 4:

PROMPT: There is no visual prompt.

ACTION: Select **UNITS** from bottom menu:

/START/CALL/FILE/DATA-M/USER/TEXT/SPLIT/UNITS

/PLOT/LOGOFF/

RESULT: Drawing/Screen Configuration options are shown in the window with asterisks indicating status of configuration (see Figure 1.4). A new prompt appears.

Step 5:

PROMPT: SELECT OPTION/YN RETURN (prompt appears at top of window)

ACTION: Select **3D** under MODE in bottom half of window. Next select **/RETURN/** beneath right-hand corner of window.

RESULT: Asterisks appear before 3D beneath MODE and WINDOW, and after /RETURN/ is selected, display area is blank and top prompt and bottom menus remain the same as in Step 4.

Step 6:

PROMPT: There is no visual prompt.

ACTION: Select **/CALL/** from bottom menu to key in drawing name or to access user's drawing file:

START/CALL/FILE/DATA-M/USER/SPLIT/UNITS/PLOT

/LOGOFF/

RESULT: CALL is underlined and a new prompt appears.

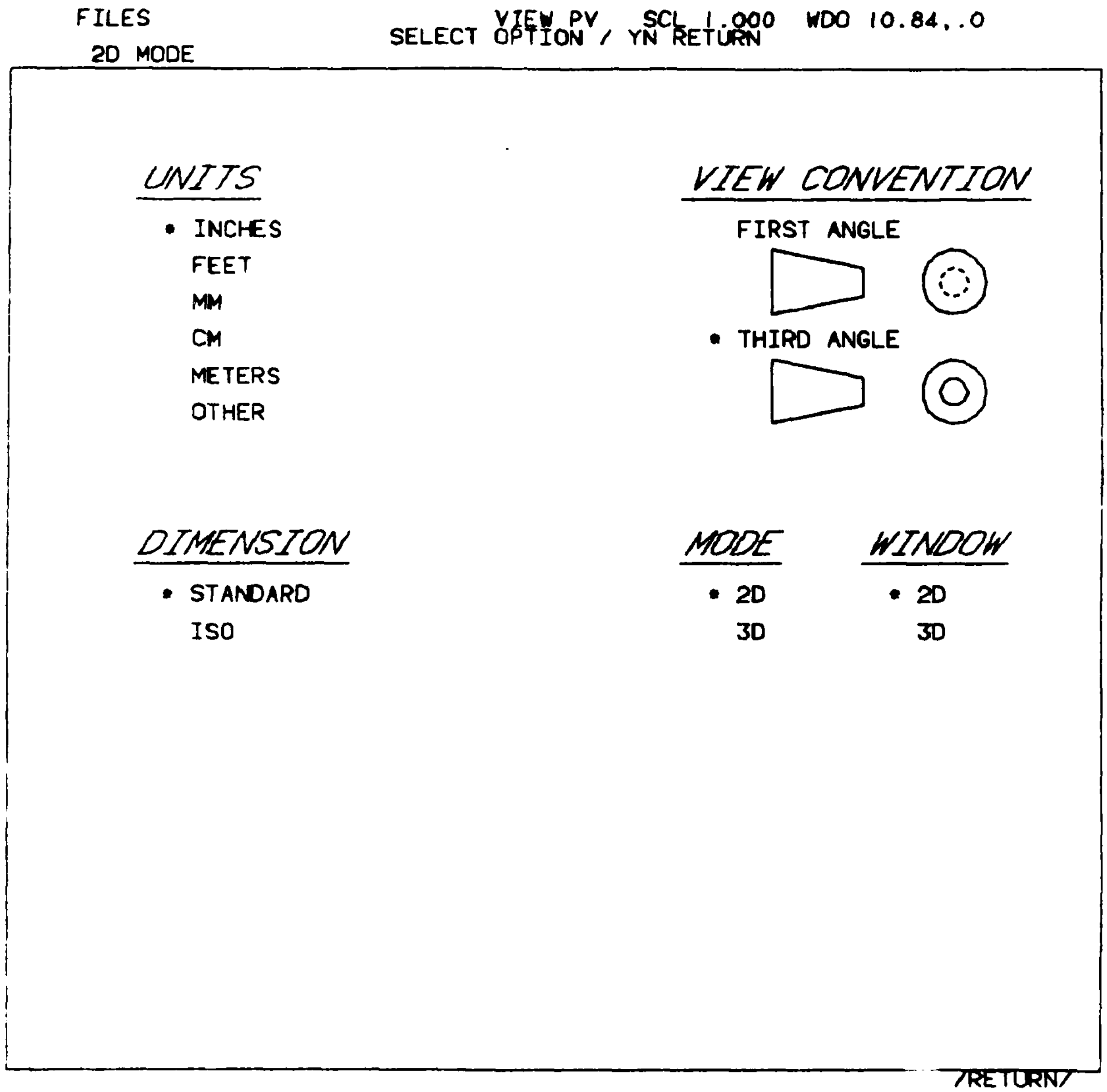


Figure 1.4. User-Defined Drawing/Screen Configurations.

Step 7:

PROMPT: KEY PN, FN / Y/N CALL (prompt appears at top of window)

ACTION: Depress **Y/N** (YES/NO) function key.

RESULT: First page of user's drawing file index appears on screen. A new prompt and a new menu appear.

Step 8:

PROMPT: SEL ID/KEY PAGE NO (prompt appears at top of window)

ACTION: Select a drawing file name (ID)

RESULT: Selected drawing is retrieved and displayed on screen. PN,FN = (ID selected) appears in the top left-hand corner of the window under FILES. The drawing may have to be oriented by depressing the CADAM Window function key. Once the drawing has been oriented as desired, the CREW CHIEF system of programs may be called.

Step 9:

PROMPT: There is no visual prompt.

ACTION: Depress **Macro Geometry** function key.

RESULT: Screen display changes, a new prompt and a new menu appear.

Step 10:

PROMPT: /SEL MACRO PROGRAM / SEL MENU / KEY LIBRARY NAME (prompt appears at top of window)

ACTION: Key in library name (**@CREW**) on ANKB; depress **<CR>**, and then depress **YES/NO** function key.

RESULT: The CREW CHIEF Main Programs menu appears (see Figure 1.3). A CADAM 3-D drawing is retrieved, and the CREW CHIEF programs are available. Information concerning the generation of the man-model and the use of the analysis functions is contained in Sections 2 through 6. If the user wishes to proceed directly to the initial generation of the man-model, the user may turn to Paragraph 2.1.2 for generation procedures.

SECTION 2

CREW CHIEF GENERATION FUNCTIONS (@CCGEN)

The CREW CHIEF Generation Functions (@CCGEN) menu contains all functions which pertain to the generation, display, and manual repositioning of the CREW CHIEF man-model. This is normally the first menu accessed, since several CREW CHIEF functions require a man-model to be defined before use. This menu contains four functions: CCINIT (CREW CHIEF Initialization, Paragraph 2.1.2), which generates and displays the man-model; REGEN (CREW CHIEF Regeneration, Paragraph 2.2.2), which regenerates the CREW CHIEF man-model display using the most recent saved data; REPOSN (CREW CHIEF Reposition, Paragraph 2.3), which places the man-model (in the desired posture and position) in the work space; and HDORT (CREW CHIEF Head Orientation, Paragraph 2.4.2), which turns the head to allow the man-model to view a new location. Choose the function to be used by selecting the abbreviation under the appropriate title (Figure 1.3).

2.1 CREW CHIEF INITIALIZATION FUNCTION (CCINIT)

2.1.1 Introduction to Initialization Function

The CREW CHIEF Initialization Function generates and displays the man-model in the designer's drawing. The designer can choose from ten body sizes (including five male and five female), four clothing types, and twelve initial postures. These choices allow multiple options to evaluate a design for maintainability. The man-model can be placed anywhere in the drawing, but is not made a permanent part of the drawing unless specifically requested. Any man-model not made a permanent part of the drawing is erased upon the generation of another man-model. This prevents the programs from permanently corrupting the designer's drawing.

The ten body sizes consist of the 1st, 5th, 50th, 95th, and 99th percentiles for both male and female, based on the Air Force maintenance technician population. Selection of the Nth percentile results in the generation of a man-model with Nth percentile height, weight, and arm length for the selected gender. Other necessary body dimensions are calculated from regressions based on these three variables. Default size is the 50th percentile male. Appendix A describes the generation of the man-model, and the selection of body size as applicable to Air Force design policy.

The four common clothing ensembles used by a technician are fatigues, fatigues with jacket, arctic, and chemical defense (see Figures B.1-B.4 in Appendix B). Details of the clothing

ensembles are contained in Appendix B. Figures B.5 through B.8 show the man-model as it appears in each of these clothing ensembles. Default clothing type is fatigues.

The twelve postures represent common postures found in a maintenance environment. These postures allow initial generation of the man-model in a posture which closely approximates the one desired. The initial postures can be further modified manually (using the Reposition Function), or automatically by the Task Analysis Functions. The twelve postures available in the Initialization Function can be seen in Figures C.1 through C.12 in Appendix C. Standing posture is the default.

2.1.2 Using the Initialization Function

These instructions for the Initialization Function assume that the CREW CHIEF system of programs has been activated and that the screen is configured as shown in Figure 1.3. If not, the user must complete the procedure described in Paragraph 1.5 to call the CREW CHIEF Main Programs menu. The next step is to generate the man-model in the desired configuration.

PROMPT: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***@CCGEN***

RESULT: The CREW CHIEF Generation Functions menu is displayed (Figure 2.1).

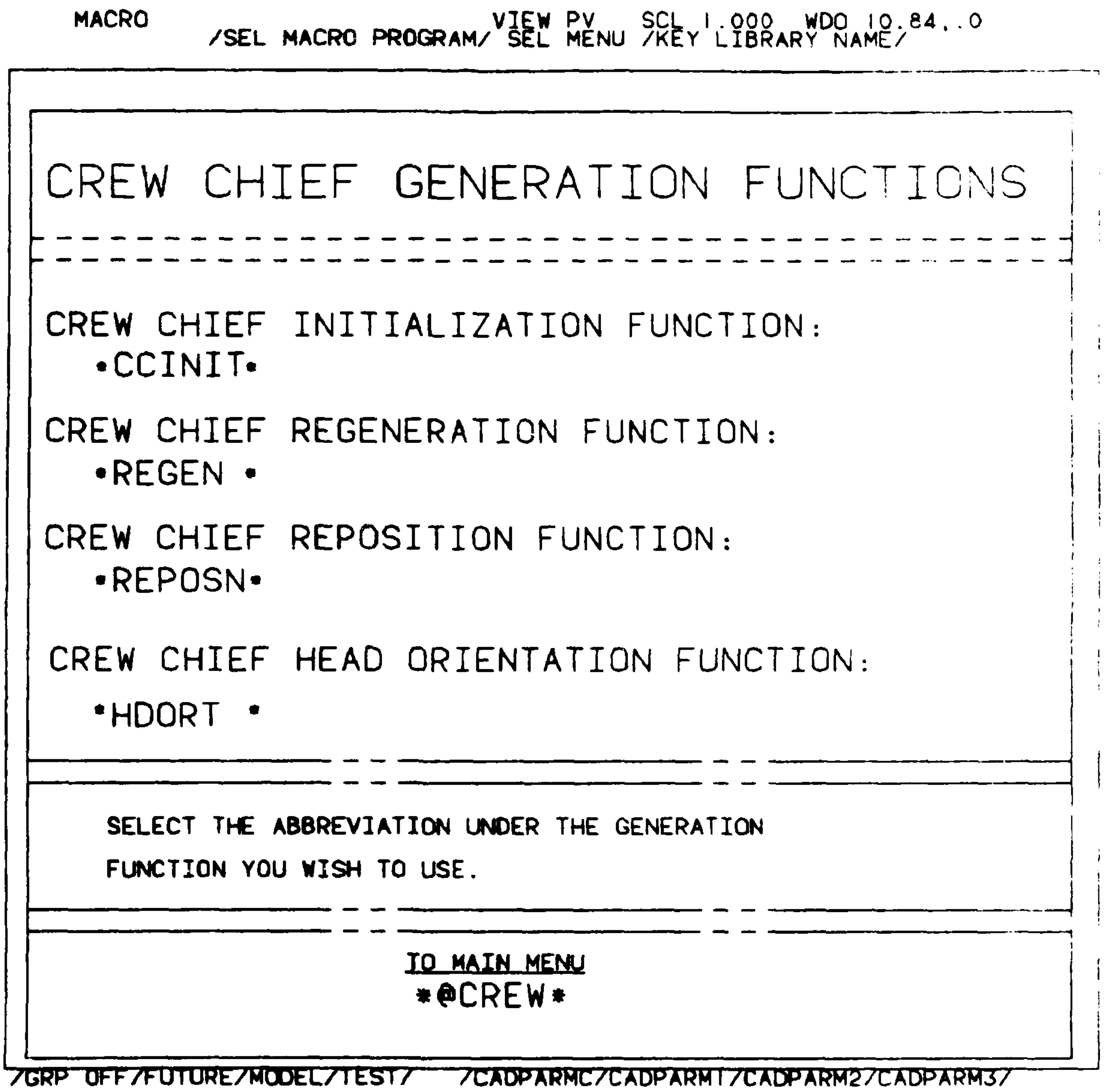


Figure 2.1. Main Menu for CREW CHIEF Generation Functions.

PROMPT: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***CCINIT***

RESULT: The Technician Definition menu is displayed. (Figure 2.2).

Three selections from the menu define the body size-gender, clothing type, and initial posture of the man-model. The range of choices is displayed with a number beside each choice. When the menu appears, the current values in use by the program are displayed near the right-hand side of the screen, i.e., INDEX = N (1 to 10) for body size and gender, CLOTHG = N (1 to 4) for clothing type, and POSTUR = N (1 to 12) for initial posture. Default values include INDEX = 3 (50% male), CLOTHG = 1 (fatigues), and POSTURE = 1 (standing). INDEX = N for the Body Size-Gender selection is highlighted. There are two possible options: (1) Accept the displayed values by selecting **/EXECUTE/** from the bottom menu; or, (2) Change any or all of the displayed values by proceeding as follows.

PROMPT: KEY IN BODY SIZE-GENDER INDEX NUMBER FROM ABOVE LIST (1-10).......INDEX = N (Prompt appears in upper third of window; INDEX = N is highlighted to indicate that Body Size-Gender selection is active.)

ACTION: Define the body size and gender of the man-model. (See Appendix A for explanation of body size percentiles.)

```
MACRO                                   VIEW PV   SCL 1.000  WDO 1.000,.0
             SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

    CCINIT

  BODY SIZE-GENDER SELECTION

           1.   1% MALE                6.   1% FEMALE
           2.   5% MALE                7.   5% FEMALE
           3.  50% MALE                8.  50% FEMALE
           4.  95% MALE                9.  95% FEMALE
           5.  99% MALE               10.  99% FEMALE

  KEY IN BODY SIZE-GENDER
  INDEX NUMBER FROM ABOVE LIST (1-10)------------------:  INDEX = 3
  CLOTHING-TYPE SELECTION

           1. FATIGUES
           2. JACKET
           3. ARCTIC
           4. CHEM DEFENSE

  KEY IN CLOTHING INDEX NUMBER FROM ABOVE LIST (1-4)----: CLOTHG= 1
  POSTURE SELECTION

           1. STAND                    7. KNEEL 1 ( ON ONE KNEE)
           2. SIT                      8. KNEEL 2 (ON TWO KNEES)
           3. BEND                     9. SQUAT
           4. SUPINE                  10. WALK
           5. PRONE                   11. CRAWL
           6. SIDE                    12. CLIMB

  KEY IN POSTURE INDEX NUMBER FROM ABOVE LIST (1-12)---:  POSTUR= 1

  TECHNICIAN DEFINITION:
    WHEN THE ABOVE DEFINITIONS ARE COMPLETE, SELECT
    / EXECUTE/ FROM THE MENU BELOW.

/ EXECUTE / RESTART / HELP / OLDPARM /                       / RETURN /
```

Figure 2.2. Technician Body Size-Gender/Clothing Type/Posture Definition Display Page.

- Accept displayed INDEX value by depressing **<CR>**.

OR:

- Change value by keying in the desired INDEX number on ANKB **<CR>**.

EXAMPLE: Key in **8** **<CR>**

RESULT: The displayed INDEX value changes to the keyed-in value (8). Highlight disappears from INDEX = 8 and Clothing Type selection at CLOTHG = 1 is highlighted.

PROMPT: KEY IN CLOTHING INDEX NUMBER FROM ABOVE LIST (1-4)........................CLOTHG = N (Prompt appears in middle third of window; CLOTHG = N is highlighted to indicate the Clothing-Type selection is active.)

ACTION: Define the type of clothing to be worn by the man-model. Clothing affects mobility and accessibility. See Appendix B for explanation of clothing types.

- Accept displayed CLOTHG value by depressing **<CR>**.

OR:

- Change value by keying in desired CLOTHG number on ANKB **<CR>**.

EXAMPLE: Key in **2** **<CR>**

RESULT: The displayed CLOTHG value changes to the keyed-in value (2). Highlight disappears from CLOTHG = 2, and POSTUR = 1 is highlighted.

PROMPT: KEY-IN POSTURE INDEX NUMBER FROM ABOVE LIST (1-12).....................POSTUR = (Prompt appears in bottom third of window; POSTUR = 1 is highlighted to indicate Posture Selection is active.)

ACTION: Define the starting posture of the man-model. See Appendix C, Figures C.1-C.12 for explanation of postures. Later these postures can be adjusted manually using the Reposition function or will be automatically adjusted when performing Task Analysis

- Accept displayed POSTUR value by depressing **<CR>**

<u>OR:</u>

- Change value by keying in desired POSTUR number on ANKB **<CR>**

EXAMPLE: Key in **8** **<CR>**

RESULT: The displayed POSTUR value changes to the keyed-in value (8). Highlight disappears from POSTUR = N, and INDEX = N is highlighted.

When the user is satisfied with the Technician Definition menu selections, he/she may continue the generation of the man-model by selecting **/EXECUTE/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains other selections which are available to the user at this time. For further information on /RESTART/, /OLDPARM/, and /RETURN/, see Section 8. /HELP/ is another selection that is available to the user, and further information is presented in Section 7.

PROMPT: TECHNICIAN DEFINITION: **WHEN THE ABOVE DEFINITIONS ARE COMPLETE, SELECT /EXECUTE/ FROM THE MENU BELOW (prompt appears in bottom third of window)**

ACTION: Select choice from the menu at bottom of window. Selecting **/EXECUTE/** will complete Technician Definition and allow continuance of the next step, positioning of the man-model.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window: /SELECT - KEY IN/SAME/

- Select **/SELECT - KEY IN/** to receive the next prompt to initially place the man-model with respect to the location of work

<u>OR:</u>

- Select **/SAME/** to create man-model in same location on the drawing where it was defined and displayed previously. The user will next be prompted to choose a display type if /SAME/ was selected. (Skip the next four prompts.) (Gender-size, clothing type, and posture type may change if the user indicates a change.)

EXAMPLE: Select **/SELECT - KEY IN/**

RESULT: New prompt appears on screen to select display type.

As a result of selecting /SELECT - KEY IN/, the user will see the following prompt:

PROMPT: SEL MENU/YN REJECT/<u>DEFINE LOCATION OF WORK</u> (prompt appears at top of window)

ACTION: Define the location of work (bolt head or target area of man-model's work) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point. The X and Y coordinates of this point determine the head of the direction vector shown in Figure 2.3. <u>The man-model always faces the location of work.</u>

- Select an existing 3-D point to define the location of work.

<u>OR:</u>

- Key in the X,Y,Z coordinates of the location of work **<CR>**.

EXAMPLE: Key in **24, 163.5, 0** on ANKB **<CR>**.

RESULT: Values keyed in (30, 0, 0) appear at top left-hand side of window, and a new prompt appears.

PROMPT: SELECT MENU/YN REJECT/<u>DEFINE DIRECTION OF MAN TO WORK</u> (prompt appears at top of window)

ACTION: Define a direction from the man-model to the Location of Work. **Note that this is NOT the location of the man-model.** Define the X,Y coordinates of a point relative to the Location of Work point. This point defines the tail point

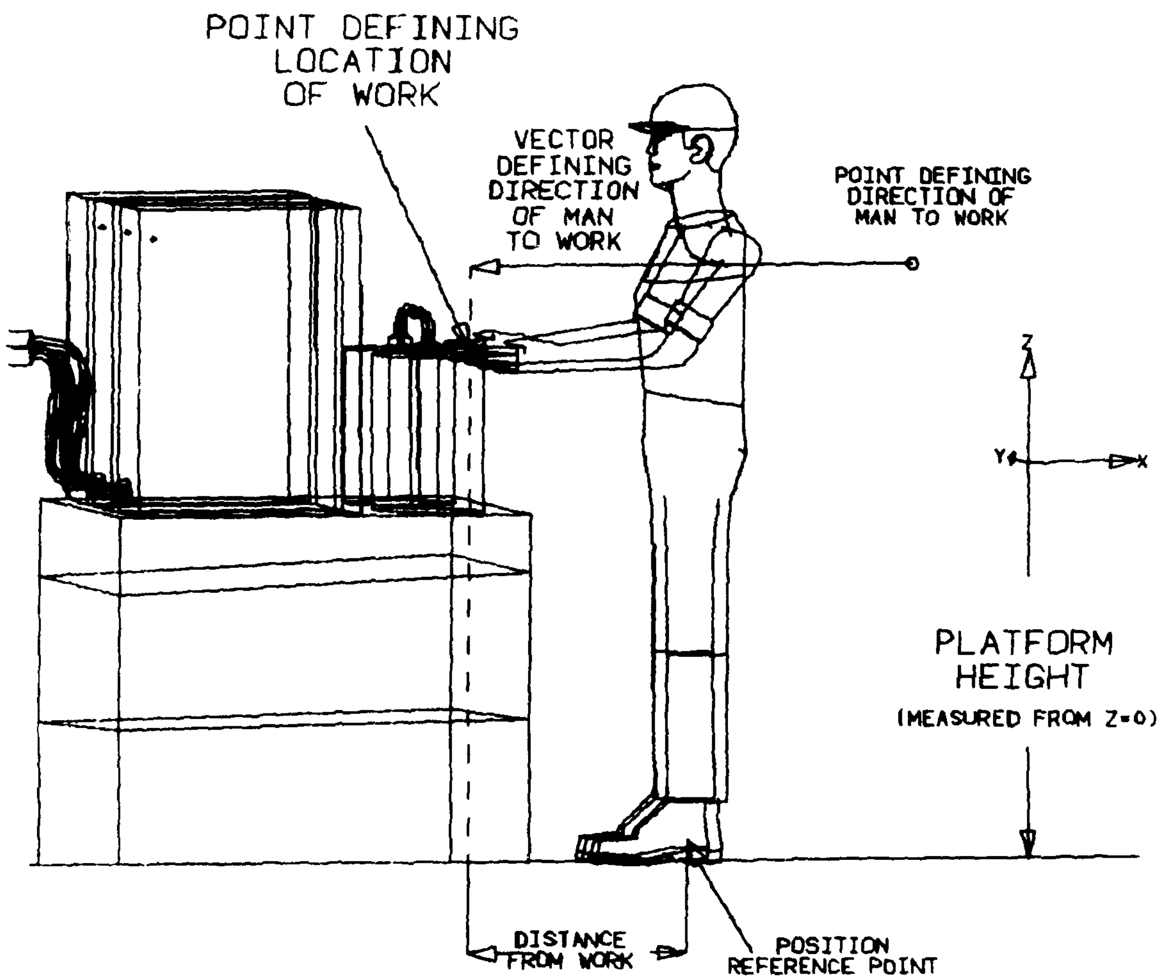


Figure 2.3. The Man-Model at a Work Station with Arrows Showing Position and Orientation Requirements.

of the direction vector along which the man-model will be placed as shown in Figure 2.3. The distance of this point from the Location of Work is not relevant at this stage of initialization.

- Select an existing point in the drawing. Only the X,Y coordinates will be used to define this direction.

OR:

- Key in the X,Y coordinates of the direction point **<CR>**.

EXAMPLE: Key in **35, 163.5 <CR>**

RESULT: Values keyed in (5, 0) appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU/YN REJECT/KEY IN DISTANCE FROM WORK (prompt appears at top of window)

ACTION: Define the horizontal distance from the Location of Work point to the man-model. The Position Reference Point of the man-model lies along the vertical plane defined by the Location of Work and the Direction to Work (Figure 2.3). (See Appendix C for location of Position Reference Points for various postures.) Key in the distance between man-model and the Location of Work **<CR>**.
Values outside the range of 6-30 inches are usually unrealistic, but this distance depends upon the location of the Position Reference Point of the selected posture as shown in Figure 2.4.

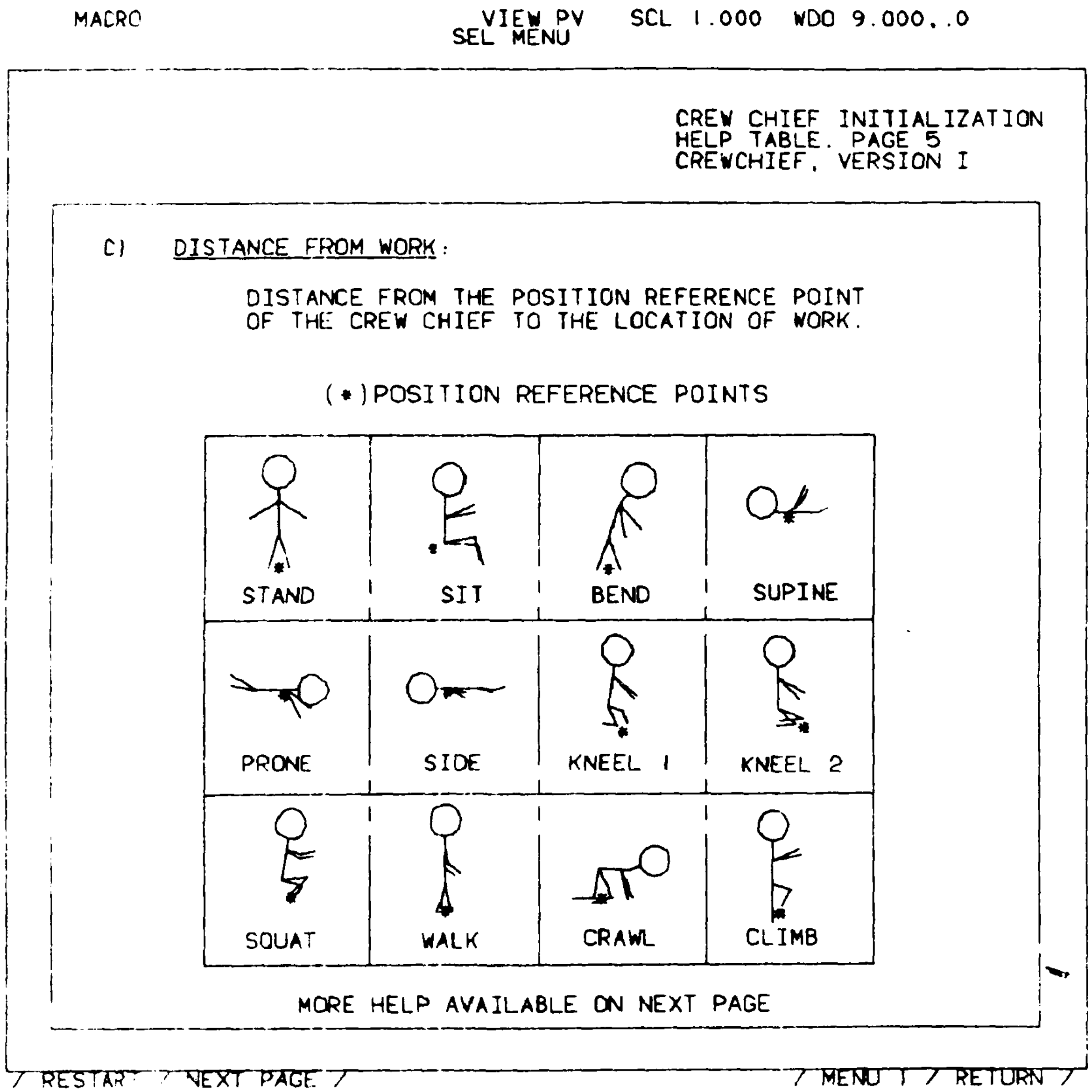


Figure 2.4. Position Reference Points.

EXAMPLE: Key in **12** <CR>.

RESULT: Value keyed in (12) appears at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Define the height of the platform or support surface upon which the man-model will be positioned. The Position Reference Point (see Figure 2.4) of the man-model will be placed at this height.

- Select **/DEFINE PLATFORM HGT/** to choose an existing 3-D point in the drawing which will represent the height (Z coordinate) of the platform or support surface, and then select an existing 3-D point.

<u>OR:</u>

- Select **/KEY IN PLATFORM HGT/** to key in the height of the platform or support surface (Z coordinate) relative to the drawing origin, and key in the Z coordinate <CR>.

EXAMPLE: Select **/KEY IN PLATFORM HGT/** and key in **-20** <CR>

RESULT: Value keyed in (30) appears at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION).

- Select **/WIRE/** to display a 3-D wire-frame man-model

TABLE 2.1. FOUR TYPES OF DISPLAY AVAILABLE FOR THE CREW CHIEF MAN-MODEL.

Type of Man-Model	Definition
(1) WIRE	This selection generates the man-model as a 3-D wire-frame figure which can be rotated and moved using the appropriate CADAM Window (PFK 27) functions. The man-model and drawing may be viewed from different points in the drawing. This type of enfleshment can be used for visually identifying potential areas of interference between the man-model and the workplace design. (See Figure 2.5.)
(2) FRONT	This type of display is the front half of the wire-frame man-model as viewed from the designer's location at the graphics scope. This display contains less clutter than the full wire-frame model, but can still be used for limited visual interference checking. Rotation of the display using CADAM functions reveals a half-shell model. (See Figure 2.6.)
(3) PROFILE	This is a profile view of the man-model, as seen from the designer's viewpoint at the graphics scope. This type of display is the least cluttered, and provides a display suitable for "finished" plots. (See Figure 2.7.)
(4) REPOSITION	This type of display is chosen when the intent is to manually reposition the man-model. The display is similar to the 3-D wire-frame created under "WIRE," but includes extra dashed lines showing the axes of joint rotation to aid in the repositioning process. (See Figure 2.8.)

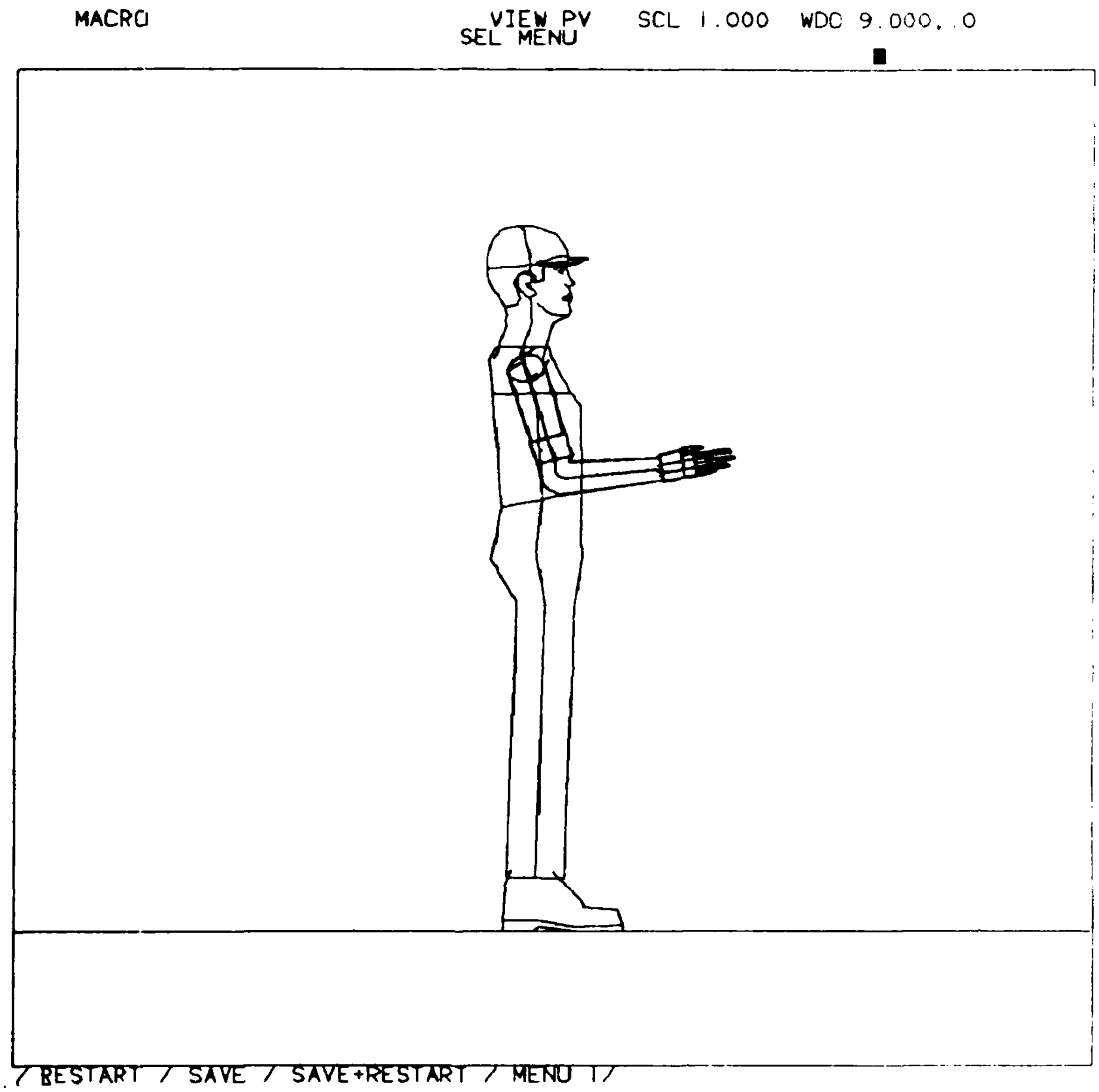


Figure 2.5. 3-D Wire-Frame Man-Model.

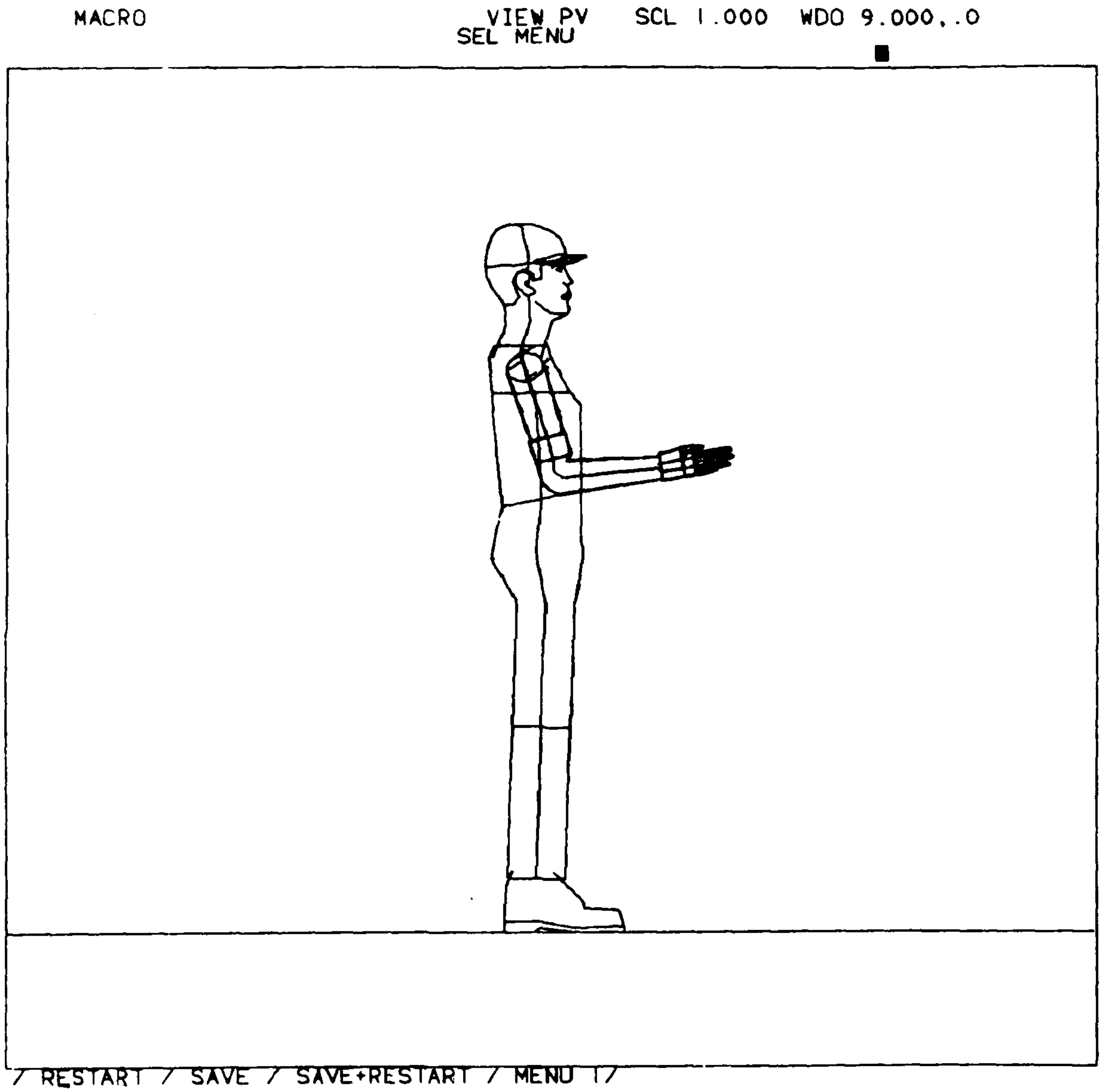


Figure 2.6. Front View of Man-Model.

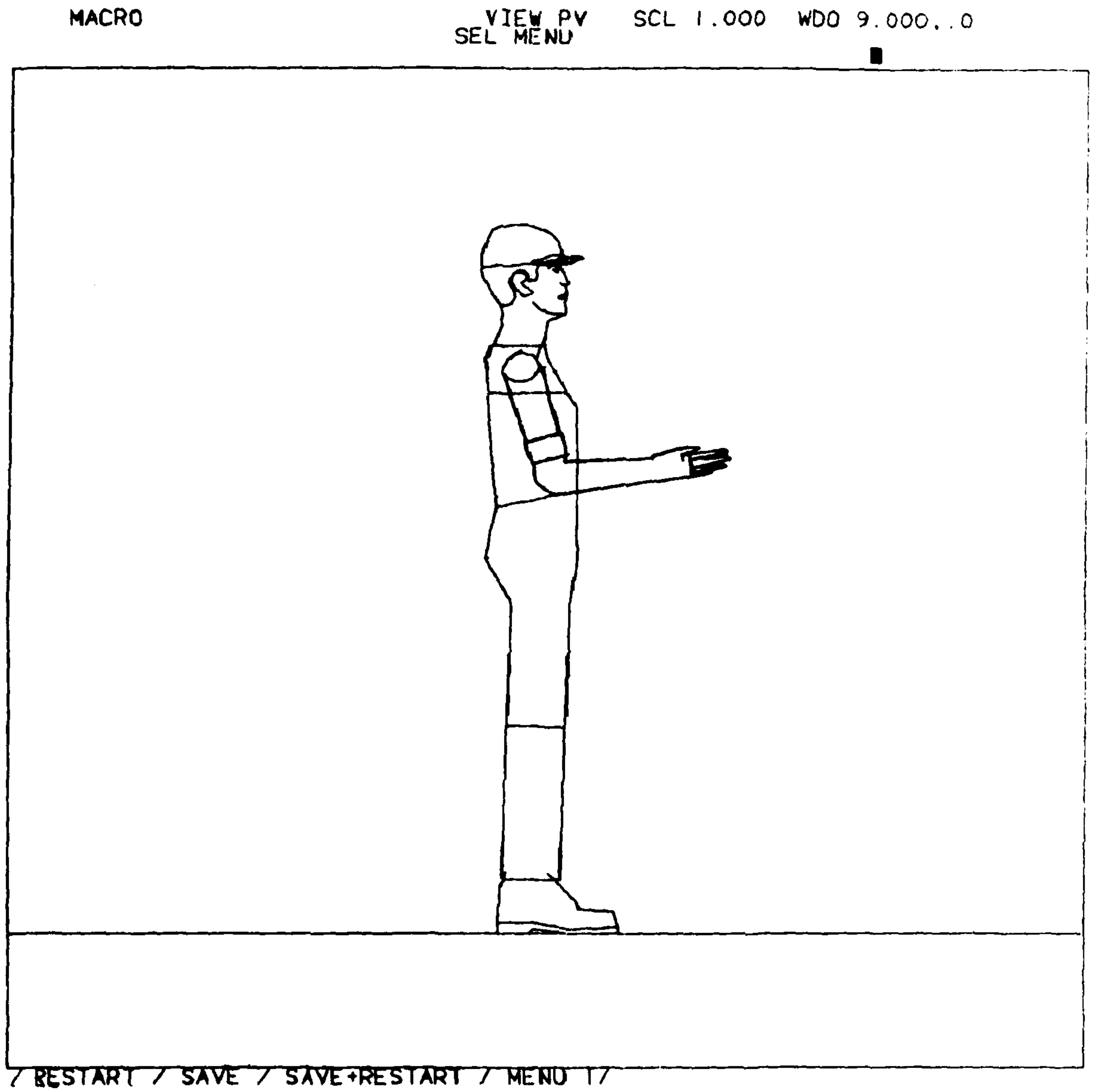


Figure 2.7. Profile View of Man-Model.

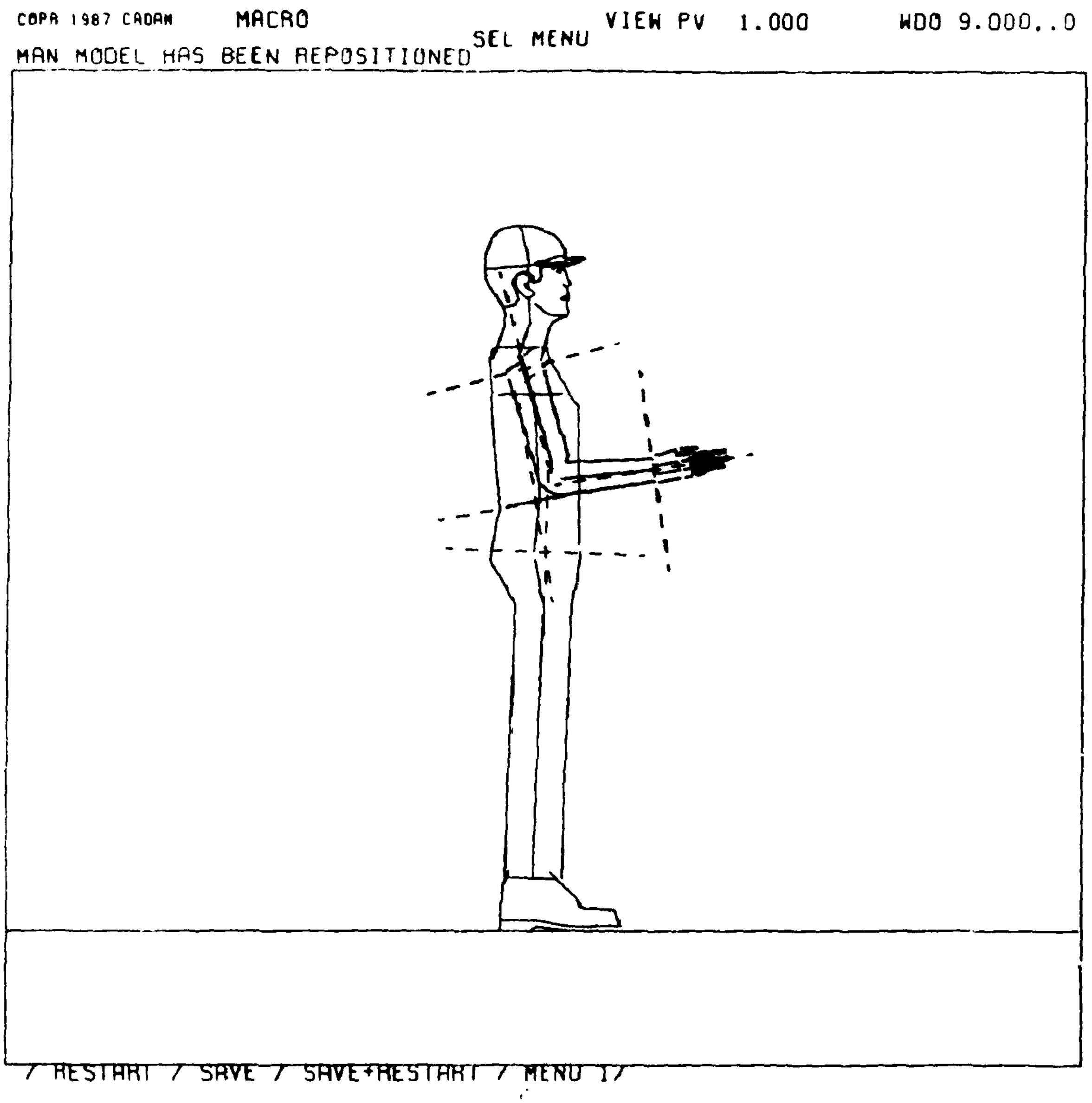


Figure 2.8. Reposition View of Man-Model.

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model at this time).

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: Man-model appears superimposed on the drawing as a wire-frame model, and new prompt and new menu appear.

NOTE: If user has followed the examples, the man-model appears kneeling on both knees with his knees 20 inches below the origin and 12 inches offset from the location of work.

When the man-model has been positioned in the drawing, the Initialization function is completed. To continue the analysis, the user will generally select **/MENU 1/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains other selections which are available to the user at this time. For further information on /RESTART/, /SAVE/, or /SAVE + RESTART/, see Section 8.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/MENU 1/** will return the user to the CREW CHIEF Generation Functions menu (Figure 2.1) without saving the current man-model. If the man-model is saved as a permanent part of the drawing, it will not be recognized by the CREW CHIEF system of programs, and therefore cannot be subsequer'ly used in Task Analysis, Vision Analysis, or Accessibility Analysis.

EXAMPLE: Select **/MENU 1/**

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

NOTE: To proceed with other analyses, the user should select **@CREW** to return to the CREW CHIEF Main Programs menu (Figure 1.3). The assembled CREW CHIEF data are maintained for use in said analyses.

Figure 2.9 diagrams the flow of actions necessary to execute an initialization of the man-model.

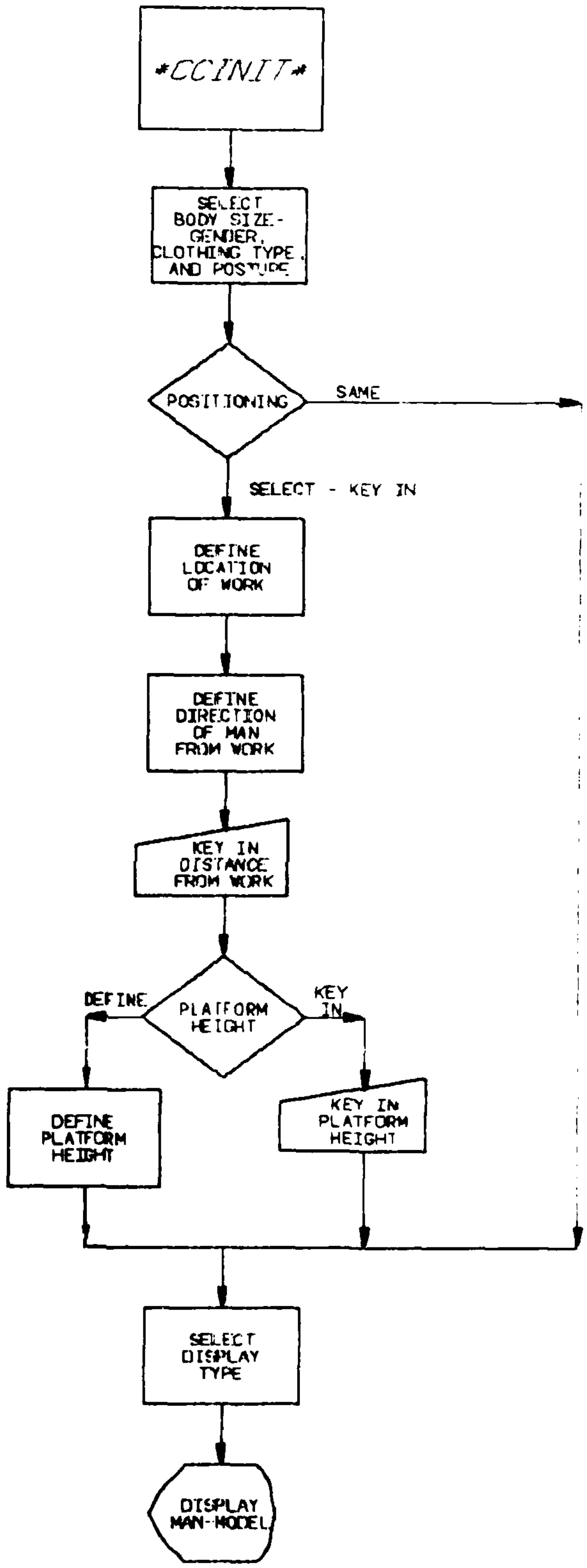


Figure 2.9. CREW CHIEF Initialization Function Flow Diagram.

2.2 CREW CHIEF REGENERATION FUNCTION (REGEN)

2.2.1 Introduction to Regeneration Function

The Regeneration Function regenerates the man-model display, using the last saved enfleshment data from the last successful positioning operation. Positioning operations can occur during the Generation functions, or during a Task Analysis, and are saved from one program run to the next if successful positioning has occurred. REGEN provides the user the opportunity to change both the type of display presented and the viewpoint from which the user sees the man-model (for profile and front view). This function can be used to recover from any catastrophic errors that may occur during interactive repositioning of the man-model. These instructions for the Regeneration function assume that the man-model has been generated at least once using the Initialization function (see Paragraph 2.1.2).

2.2.2 Using the Regeneration Function

To use the Regeneration function, key in **@CREW** on the ANKB, followed by **<CR>**, which will cause the CREW CHIEF Main Programs menu to appear on the screen (see Figure 1.3).

PROMPT: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***@CCGEN***

RESULT: The CREW CHIEF Generation Functions menu is displayed (Figure 2.1)

PROMPT: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***REGEN***

RESULT: A new prompt appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

<u>OR:</u>

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

<u>OR:</u>

- Select **/RESPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/PROFILE/**

RESULT: Man-model appears superimposed on the drawing as a profile model, and new prompt and new menu appear.

NOTE: If user has followed the examples, the man-model will appear as it did in the last successful generation. The only item which may change is the display type.

When the man-model has been positioned in the drawing, the Regeneration function is completed. To continue the analysis, the user will generally select **/MENU 1/** from the menu at the bottom of the window. The bottom menu is a CADAM-supplied menu which also contains other selections which are available to the user at this time. For further information on / RESTART /, / SAVE /, or / SAVE+RESTART /, see Section 8.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/MENU 1/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-model. If the man-model is saved as a permanent part of the drawing, it will not be recognized by the CREW CHIEF system of programs, and therefore cannot be subsequently used in Task Analysis, Vision Analysis, or Accessibility Analysis.

EXAMPLE: Select **/MENU 1/**

RESULT: Program returns to CREW CHIEF Generation Functions menu

NOTE: To continue an analysis, the user should select **@CREW** to return to the CREW CHIEF Main Programs menu.

Figure 2.10 diagrams the flow of actions necessary to execute a regeneration of the man-model.

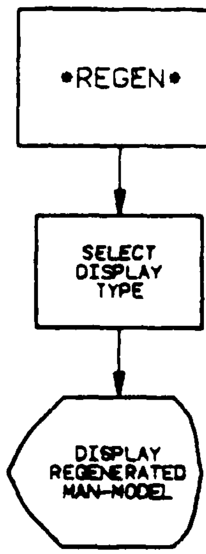


Figure 2.10. CREW CHIEF Regeneration Function Flow Diagram.

2.3 CREW CHIEF REPOSITION FUNCTION (REPOS) (Not Available at This Time)

The Resposition function is designed to augment the Task Analysis functions which will usually position the man-model in the chosen position. However, sometimes an uncommon position or a position necessitating movement of peripheral body sections may be desired. For example, a reach may only require movement of an arm, but the user may also require that the body be twisted or a leg be moved. Reach will not move these peripheral sections unless the movements are required for a successful reach. Reposition allows movement of up to twelve body sections at any time. When the man-model is regenerated using the Reposition function, mobility restraints will still be enforced, but interference is not checked. It is possible, but slower, to accomplish a reach using only the Reposition function.

Currently, the interface for the Reposition function is unavailable. If the user selects this function, a "PROGRAM NOT AVAILABLE" message is displayed and the user selects /RETURN/ from the CADAM-supplied menu at the bottom of the window to return to the CREW CHIEF Generation Functions menu (Figure 2.1).

2.4 CREW CHIEF HEAD ORIENTATION FUNCTION (HDORT)

2.4.1 Introduction to Head Orientation Function

This function allows the user to specify a new point toward which the man-model will turn its head as far as mobility constraints will allow. The man-model's head is oriented to look toward the new location instead of toward the previously specified location.

2.4.2 Using the Head Orientation Function

To use the Head Orientation Function, key in **@CREW <CR>** on the ANKB, which will cause the CREW CHIEF Main Programs menu to appear on the screen (see Figure 1.3).

PROMPT: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***@CCGEN***

RESULT: The CREW CHIEF Generation Functions menu is displayed (see Figure 2.1)

PROMPT: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE (prompt appears at bottom third of window)

ACTION: Select the abbreviation under the function to be performed

EXAMPLE: Select ***HDORT***

RESULT: New prompt appears

PROMPT: SEL MENU/YN REJECT/<u>DEFINE TARGET POINT</u>

ACTION: Select or key in a 3-D point which will represent the point toward which the man-model will turn its head. If mobility constraints will allow, the man-model will look directly at the point. If mobility constraints do not allow desired head positioning, the man-model's head will turn as far as possible toward the point. To determine the man-model's new head orientation:

- Select an existing 3-D point in the drawing

<u>OR:</u>

- Key in X,Y,Z coordinates of the target point **<CR>**

EXAMPLE: Key in **60, 10, 10 <CR>**

RESULT: New prompt appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION).

- Select **/WIRE/** to display a 3-D wire-frame man-model

<u>OR:</u>

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: New prompt appears

PROMPT: YN SAME OR SEL MENU (prompt appears at top of window)

ACTION: Selecting **/EXECUTE/** from the bottom menu will result in the orientation of the head. The bottom menu is a CADAM-supplied menu which also contains other selections which are available to the user at this time. For further information on / RESTART / and / RETURN /, see Section 8.

EXAMPLE: Select **/EXECUTE/**

RESULT: Man-model appears superimposed on the drawing as a wire-frame man-model with its head orientated toward the target point.

When the man-model's head has been orientated, the Head Orientation function has been completed. To continue the analysis, the user will generally select **/MENU 1/** from the menu at the bottom of the window.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select choice from CADAM menu at bottom of window. Selecting **/MENU 1/** will return the user to the CREW CHIEF Generation Functions menu without saving the current man-mo .

EXAMPLE: Select **/MENU 1/**

RESULT: Program returns to CREW CHIEF Generation Functions menu

NOTE: To continue an analysis, the user should select **@CREW** to return to the CREW CHIEF Main Programs menu.

Figure 2.11 diagrams the flow of actions necessary to execute a head orientation of the man-model.

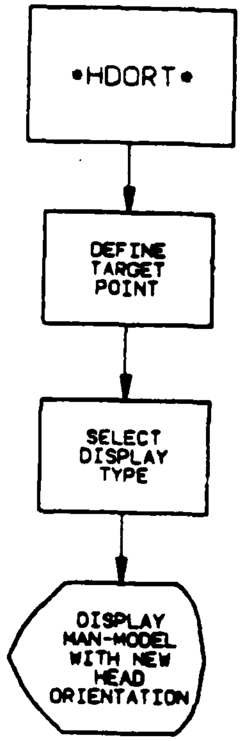


Figure 2.11. CREW CHIEF Head Orientation Function Flow Diagram.

SECTION 3

MAINTENANCE TASK ANALYSES (@TSKAN)

The Maintenance Task Analyses function is designed to evaluate the interactions of the CREW CHIEF man-model and the user's design with respect to certain physical characteristics of the man-model. The function is separated into three parts: the Tool Analysis function (Paragraph 3.1), the Materials Handling function (Paragraph 3.2), and the Connector Analysis function (Paragraph 3.3).

The Tool Analysis function evaluates the ability to reach, with a tool and from a designated posture and position, a specified task point. This includes the ability to reach around obstacles between the man-model (holding the tool) and the task point. For specified wrenches, once it is determined that the point can be reached, the strength capability (force that can be applied in loosening and tightening bolts) for the particular size man-model (1st, 5th, 50th, 95th, and 99th percentiles), posture, and tool relationship will be displayed. Strength analysis with tools is limited to torque with wrenches because this is the only tool task for which strength criteria are available in Air Force technical orders. (See Appendix D for more information on hand tools.) A limited visual analysis of tool clearance may be made when the tool has been positioned. Detailed analyses of man-model and work station interference are available with the Interference Analysis and Work Envelope

Analysis functions contained in the Accessibility Analyses function menu (see Section 5).

The Materials Handling Analysis function evaluates the capabilities of the technician to lift, push, pull, turn, hold in position, carry, or reach an object. Often these objects are the Line Replaceable Units (LRUs). In this function there is also a table displaying the 1st, 5th, 50th, 95th, and 99th percentile strength capabilities for the starting and ending positions and size and weight of the object, all of which are available to complete the task being simulated. Currently, strength data are available for CARRY, HOLD, LIFT, PUSH AND PULL.

The Connector Analysis function evaluates the capability of the technician to attach a connector at a specified location. In this function there will also be a table of the strength capability related to grip used and size of the connector. This table displays the torque applied in inch-pounds across five percentiles (1st, 5th, 50th, 95th, and 99th).

The Maintenance Task Analyses function is initiated as follows. First call the CREW CHIEF Main Programs menu (see Figure 1.3) by keying in **@CREW** on the ANKB and following with a **<CR>**.

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in bottom of window)

ACTION: Select the abbreviation for the analysis to be performed

EXAMPLE: Select ***@TSKAN***

RESULT: The CREW CHIEF Task Analyses Function menu appears (Figure 3.1).

Choose the desired analysis function by selecting **@TOOL**, **@MMH**, or **CONNECTOR**.

For a general guide to orient the man-model, see CREW CHIEF Initialization (Paragraph 2.1.2) or Quick Reference (Paragraph 9.1.1). This orientation includes standing posture, and the location of work is 24, 163.5, 0; the direction of man to work is 35, 163.5; the distance from work is 12.0; and the platform height is -20.

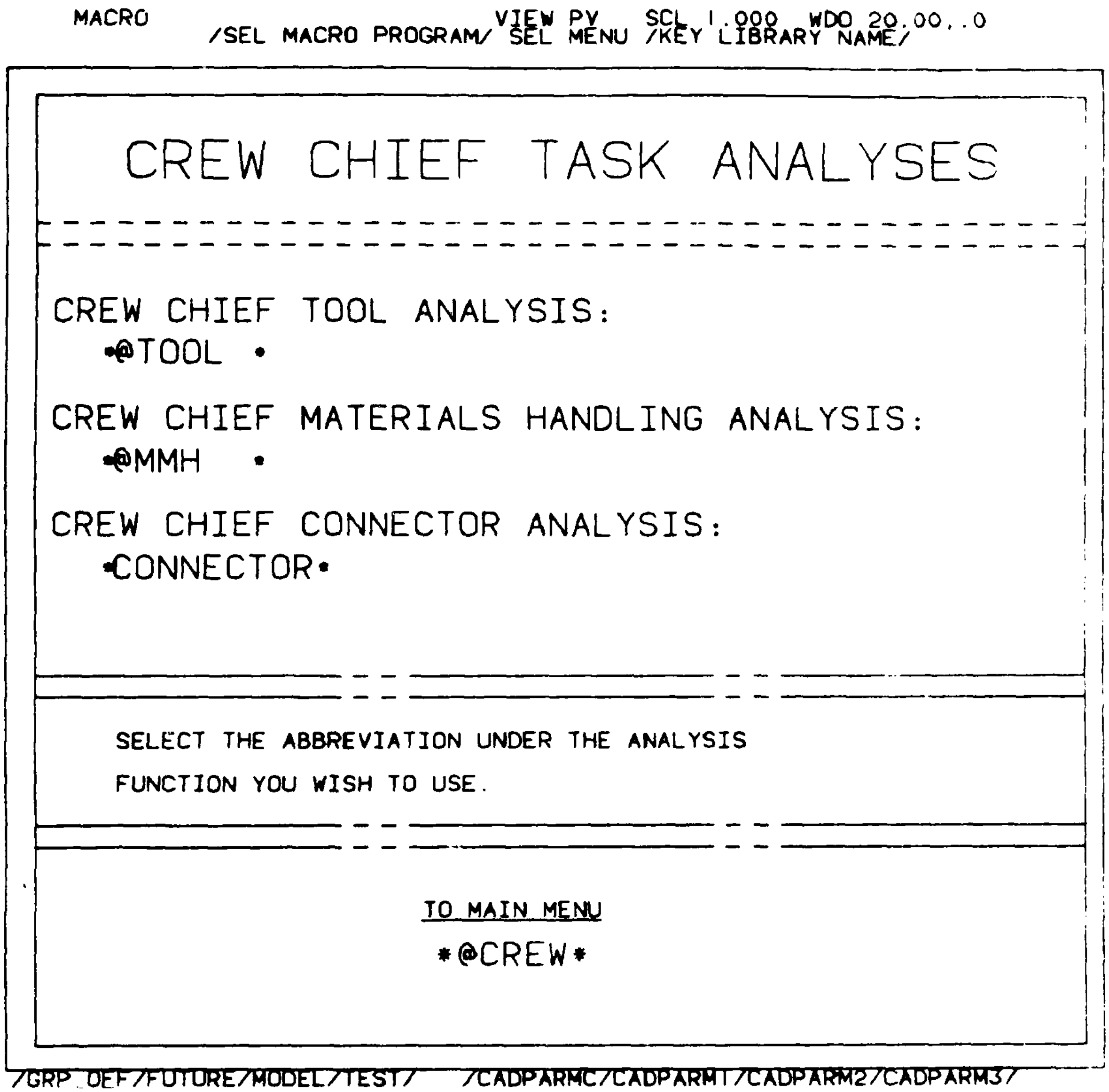


Figure 3.1. CREW CHIEF Task Analyses Function Menu.

3.1 USING THE TOOL ANALYSIS FUNCTION (@TOOL)

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in bottom third of window)

ACTION: Select the abbreviation under the CREW CHIEF Task Analysis function to be performed (see Figure 3.1)

EXAMPLE: Select ***@TOOL***

RESULT: The Tool Selection menu is displayed (Figure 3.2)

A full description of each tool and its variations is included in Appendix D. "@WRENCHES," "@PLIERS," and "@SCREWDRIVER" call additional menus to further define tool type and size within a classification. The other menu items call a tool with standard dimensions. The procedure for defining tool type and size within a classification is similar. The classifications of tools are found within the following categories and respective paragraphs: wrenches without sockets, including open end, combination end, standard box end, deep offset box end, ratcheting box end, and allen (Paragraph 3.1.1); wrenches with sockets, including breaker bar, torque, ratchet, and speedhandle (Paragraph 3.1.2); nutdrivers (Paragraph 3.1.3); screwdrivers (Paragraph 3.1.4); pliers (Paragraph 3.1.5); and miscellaneous tools, including hammer, chisel/hammer, files, scraper, hacksaw, drill, and sander (Paragraph 3.1.6).

3.1.1 Wrenches Without Sockets

This category of tools includes the following wrenches: open end, combination end, standard box end, deep offset box end, ratcheting box end, and allen.

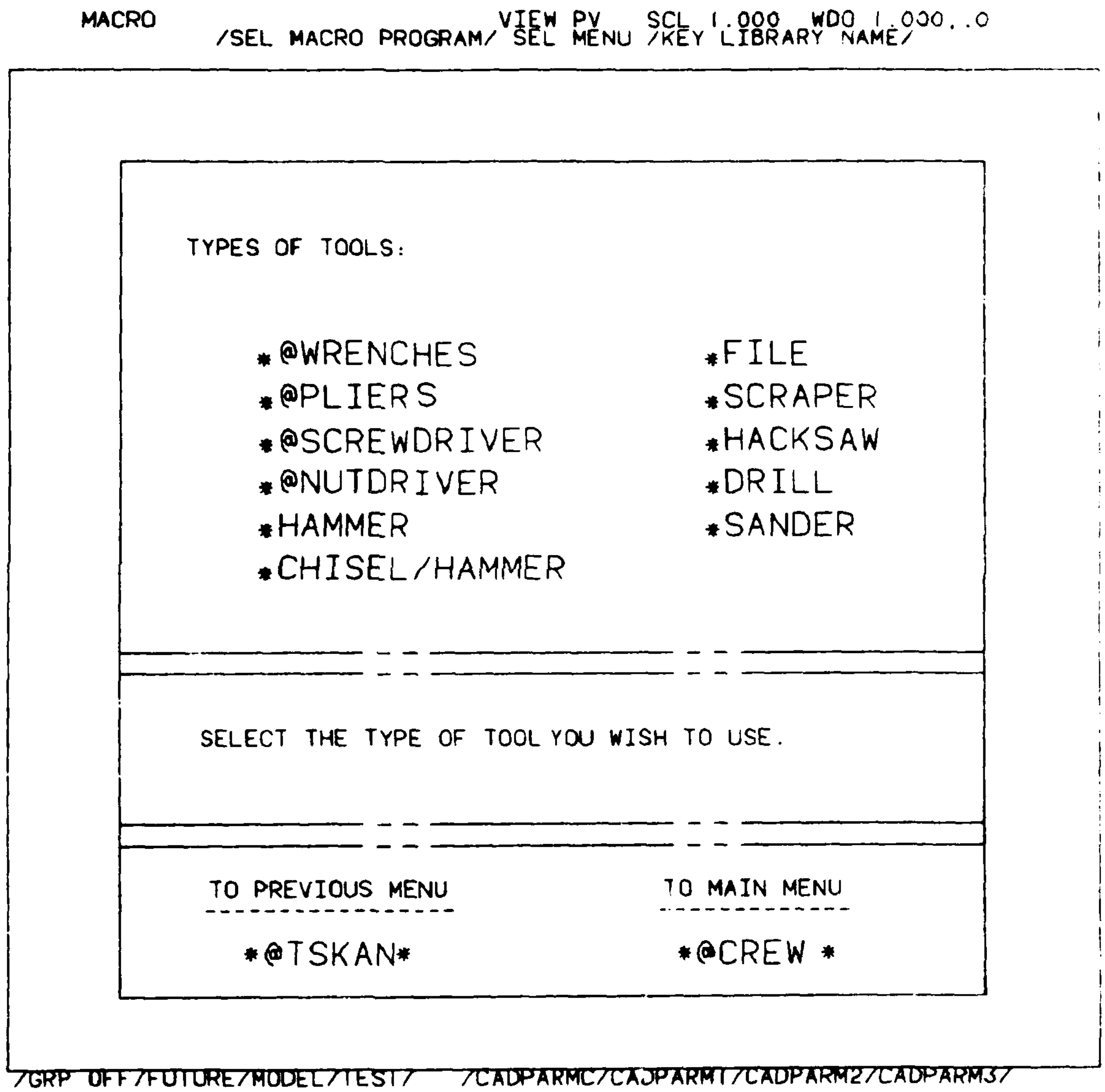


Figure 3.2. Tool Selection Menu.

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the type of tool to be used in the analysis. (See Appendix D for a discussion of hand tools.)

EXAMPLE: Select **@WRENCHES**

RESULT: Wrench Selection menu appears (Figure 3.3).

PROMPT: SELECT THE TYPE OF WRENCH TO USE (prompt appears at bottom of window)

ACTION: Select the type of wrench to be used in the analysis (see Figure 3.3)

EXAMPLE: Select ***@OPEN END**

RESULT: Bolt Diameter Selection menu appears (Figure 3.4).

PROMPT: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WISH TO USE (prompt appears at lower quarter of window)

ACTION: Select the abbreviation corresponding to the bolt diameter to be used in the analysis (Figure 3.4). This is the diameter of the bolt threads, <u>not</u> the diameter of the bolt head. The diameter selected determines the size of the wrench depicted. If one of the other wrenches without sockets is selected, the title "OPEN_" will not be used to call the bolt diameter menu for other types of wrenches. For example, "COMB_" indicates combination end wrenches, "DEEP_" indicates deep offset box end wrenches, etc.

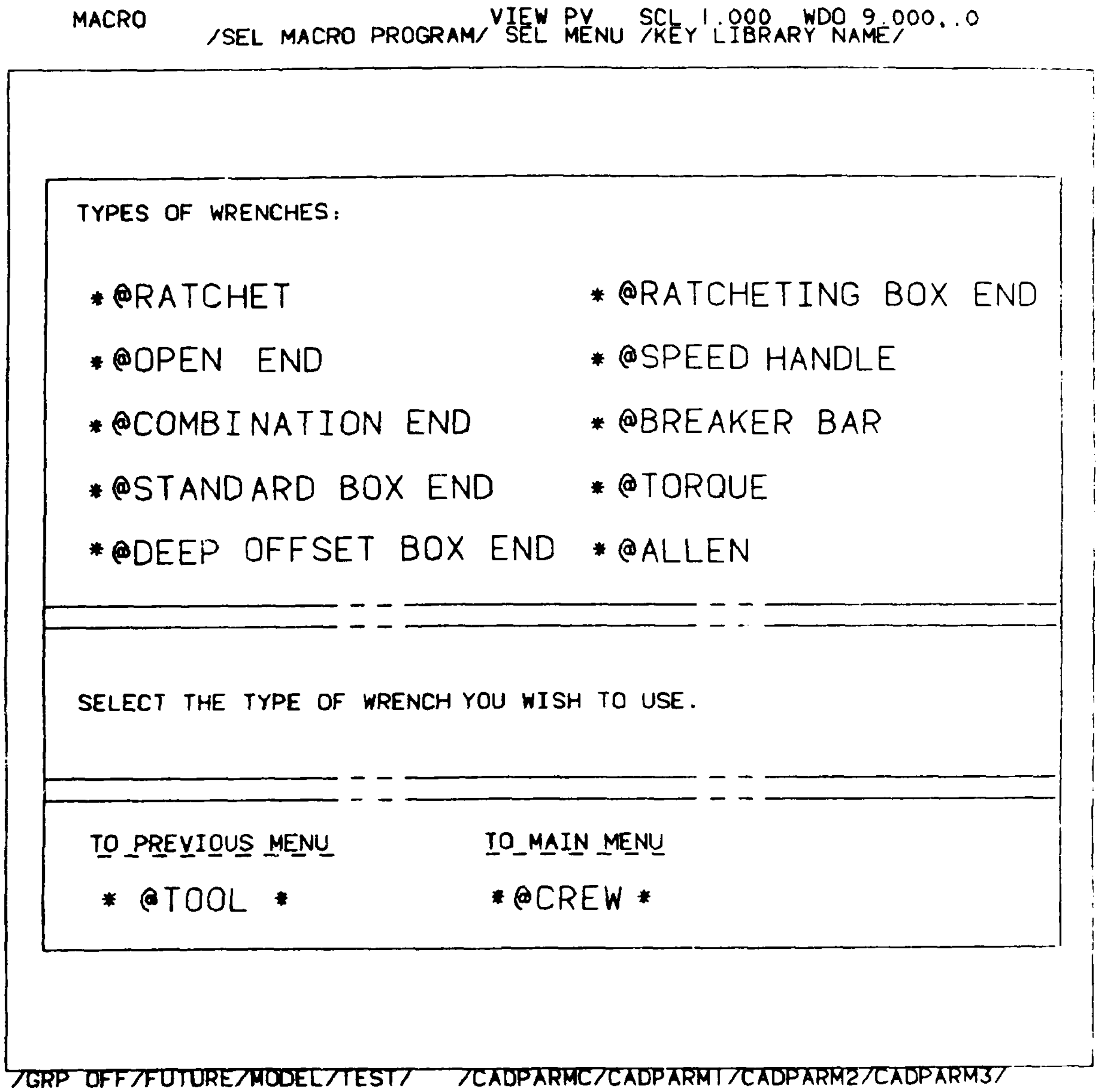


Figure 3.3. Wrench Selection Menu.

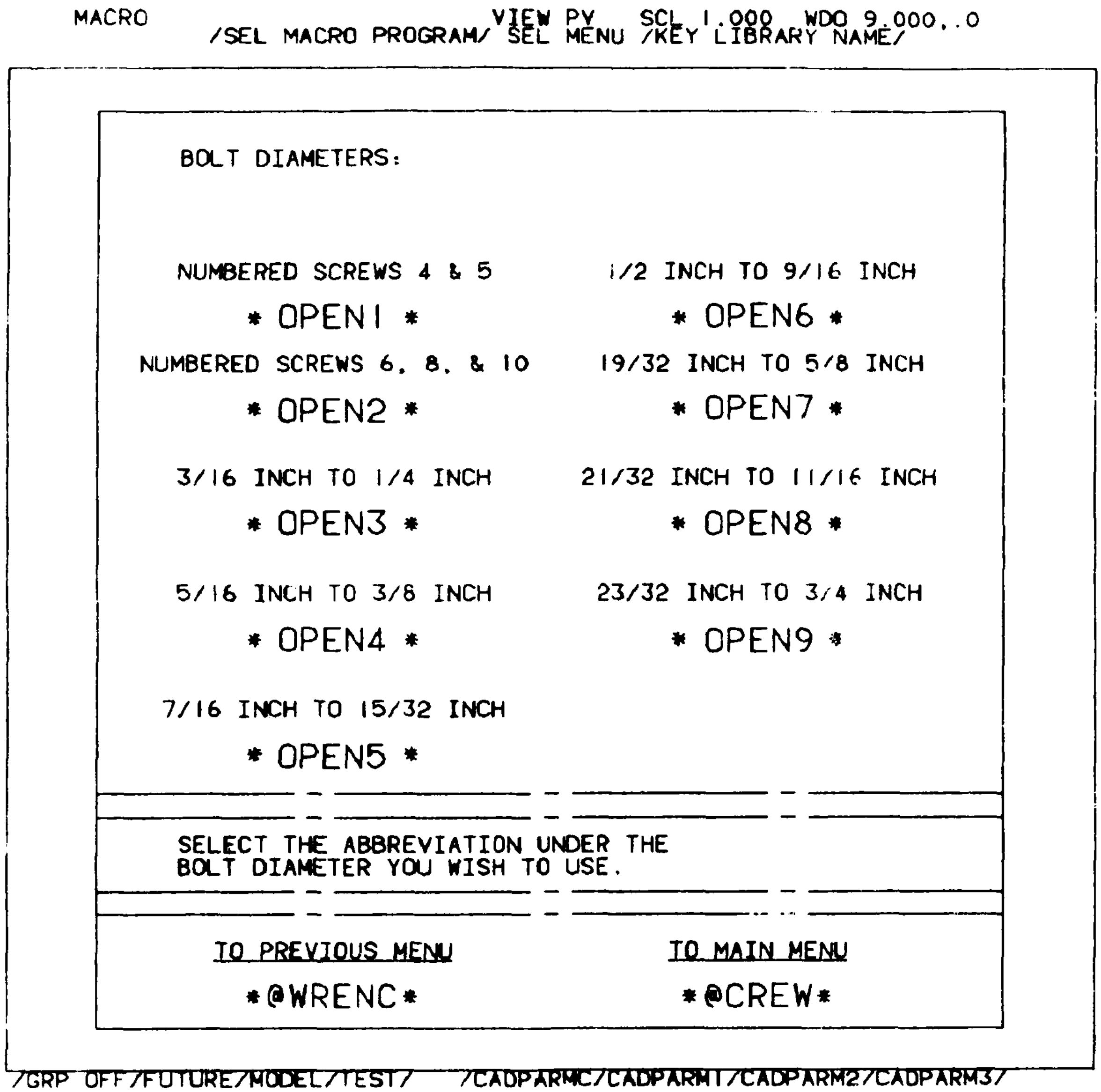


Figure 3.4. Bolt Diameter Selection Menu for Open End Wrenches.

EXAMPLE: Select ***OPEN3***

RESULT: Hand and Grip Type Selection menu appears (Figure 3.5).

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE (prompt appears in lower quarter of window)

ACTION: Select which hand will hold the tool in the analysis (Figure 3.5). The most commonly used hand (RIGHT) in which to hold a tool is the default and will apppear with YES when the menu appears initially.

- Accept the default hand (**RIGHT**)

OR:

- Choose the left hand by selecting **LEFT**

OR:

- Choose both hands by selecting **BOTH**

EXAMPLE: Select **LEFT**

RESULT: RIGHT and BOTH = NO, and LEFT = YES

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE (prompt appears in the lower quarter of window)

ACTION: Select the grip type to be used in the analysis (see Figure 3.5). There will be separate menus for the grip types for different tools. The different grip types have a value of YES or NO. The most commonly used grip type for the particular tool is the default and will appear with YES when the menu appears initially.

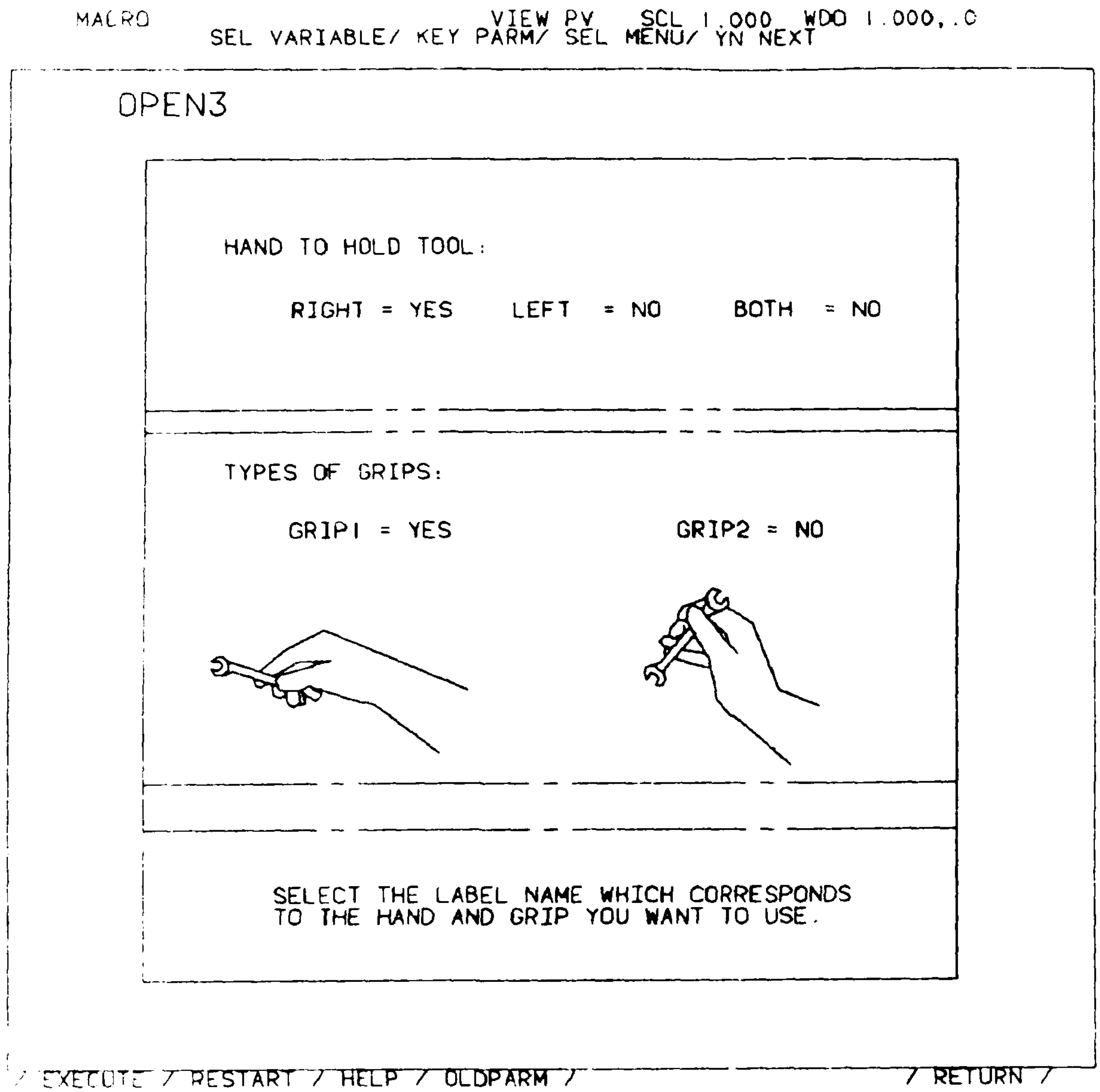


Figure 3.5. Hand and Grip Type Selection Menu for Open End Wrenches.

- Accept the default grip (**GRIP1**)

OR:

- Choose the alternate grip by selecting **GRIP2**

EXAMPLE: Select **GRIP2**

RESULT: GRIP1 = NO and GRIP2 = YES.

When the user is satisfied with the tool definition and grip selections, he/she may continue the tool analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM/ SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from bottom menu.

Selecting **/EXECUTE/** will complete Tool and Grip Definition and will allow the user to continue to the next step, tool orientation.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU / YN REJECT / DEFINE HEAD POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the location of the head point (center point of the bolt head) of the attach vector by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the tail point of the attach vector (to determine orientation of the bolt axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the orientation of the bolt axis

OR:

- Key in the X,Y,Z coordinates which define the orientation of the bolt axis **<CR>**

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE DIRECTION OF TOOL HANDLE (prompt appears at top of window)

ACTION: Define the direction that the tool handle points away from the bolt by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point in the drawing

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**

EXAMPLE: Key in **35, 170, 40 <CR>**

RESULT: Values keyed in (35, 170, 40) appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used during the REACH analysis from the bottom menu.

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

OR:

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

OR:

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

OR:

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement.

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU / YN REJECT / INDICATE CENTER OF PLOT

(prompt appears at bottom of window)

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will

appear on the screen. If the tool type selected is the breaker bar or the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION).

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perfor the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.6 diagrams the flow of actions necessary to execute a tool analysis for wrenches without sockets.

To continue the analysis, the user will select **/MENU 1/** from the bottom of the window and then will select **@CREW** to return to CREW CHIEF Main Programs menu or select **@WRENCH** to return to the WRENCH selection menu.

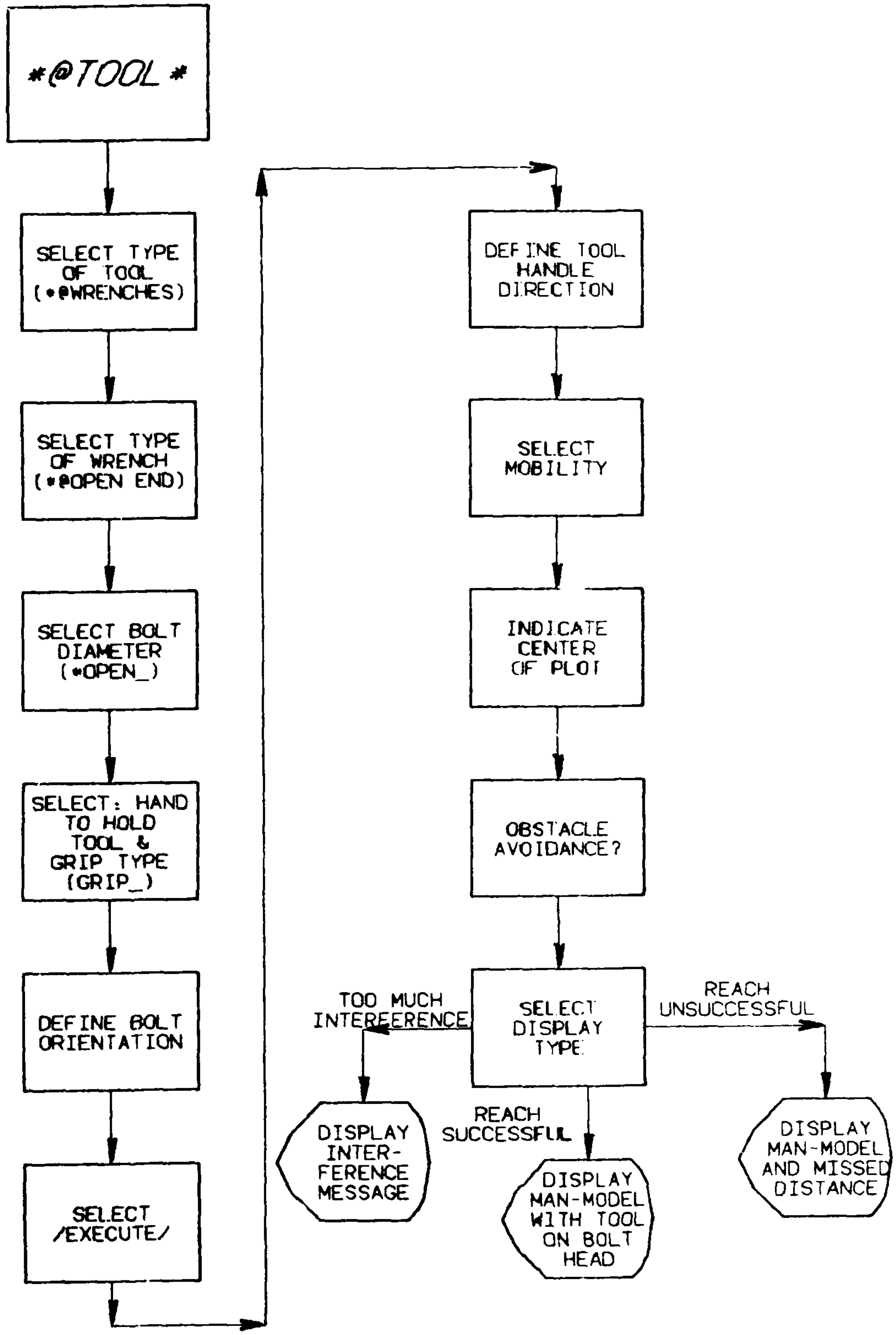


Figure 3.6. Tool Analysis Flow Diagram for Wrenches Without Sockets.

3.1.2 Wrenches With Sockets

This category of tools includes the following wrenches: breaker bar, torque, ratchet, and speedhandle. For this example a ratchet wrench was selected.

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE
(prompt appears in lower third of window)

ACTION: Select the type of tool to be used in the analysis. (See Appendix D for a discussion of hand tools.)

EXAMPLE: Select ***@WRENCHES**

RESULT: Wrench Selection menu appears (Figure 3.3)

PROMPT: SELECT THE TYPE OF WRENCH YOU WISH TO USE
(prompt appears in lower third of window)

ACTION: Select the type of wrench to be used in the analysis (see Figure 3.3).

EXAMPLE: Select ***@RATCHET**

RESULT: Bolt Diameter Selection menu appears (Figure 3.7).

PROMPT: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WISH TO USE (prompt appears in the lower third of window)

ACTION: Select the abbreviation corresponding to the bolt diameter to be used in the analysis (see Figure 3.7). This is the diameter of the bolt threads, <u>not</u> the diameter of the bolt head. The diameter of the bolt selected determines the size of the wrench selected. If one of the other wrenches with sockets has been chosen, the title "@RATC__" would

MACRO VIEW PV SCL 1.000 WDO 9.000,..
/SEL MACRO PROGRAM/ SEL MENU /KEY LIBRARY NAME/

BOLT DIAMETERS:

NUMBERED SCREWS

* @RATC1 *

3/16 INCH TO 1/2 INCH

* @RATC2 *

9/16 INCH TO 1 INCH

* @RATC3 *

SELECT THE ABBREVIATION UNDER THE
BOLT DIAMETER YOU WISH TO USE.

TO PREVIOUS MENU — TO MAIN MENU

* @WRENC * — * @CREW *

/GRP OFF/FUTURE/MODEL/TEST/ /CADPARMC/CADPARM1/CADPARM2/CADPARM3/

Figure 3.7. Bolt Diameter Selection Menu for Ratchet Wrenches.

not be used to call the Bolt Diameter menu. For example, "@BRKR__" indicates breaker bar wrenches.

EXAMPLE: Select ***@RATC2***

RESULT: Tool Handle Length Selection menu appears (Figure 3.8).

PROMPT: SELECT THE TOOL LENGTH YOU WISH TO USE (prompt appears in lower half of window)

ACTION: Select the abbreviation corresponding to the length of the ratchet handle (regular or long) to be used in the analysis (see Figure 3.8). The title "RATC__" will not be used to call the handle length selection menu for other types of wrenches. For example, "BRKR__" indicates breaker bar wrenches, and "TORQ__" indicates torque wrenches.

EXAMPLE: Select ***RATC7***

RESULT: Hand and Grip Type Selection menu appears (Figure 3.9).

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE (prompt appears on lower quarter of window)

ACTION: Select which hand will hold the tool in the analysis (see Figure 3.9). The most commonly used hand (RIGHT) is the default and will appear with YES when the menu appears initially.

- Accept the default hand (**RIGHT**)

<u>OR:</u>

- Choose the left hand by selecting **LEFT**

<u>OR:</u>

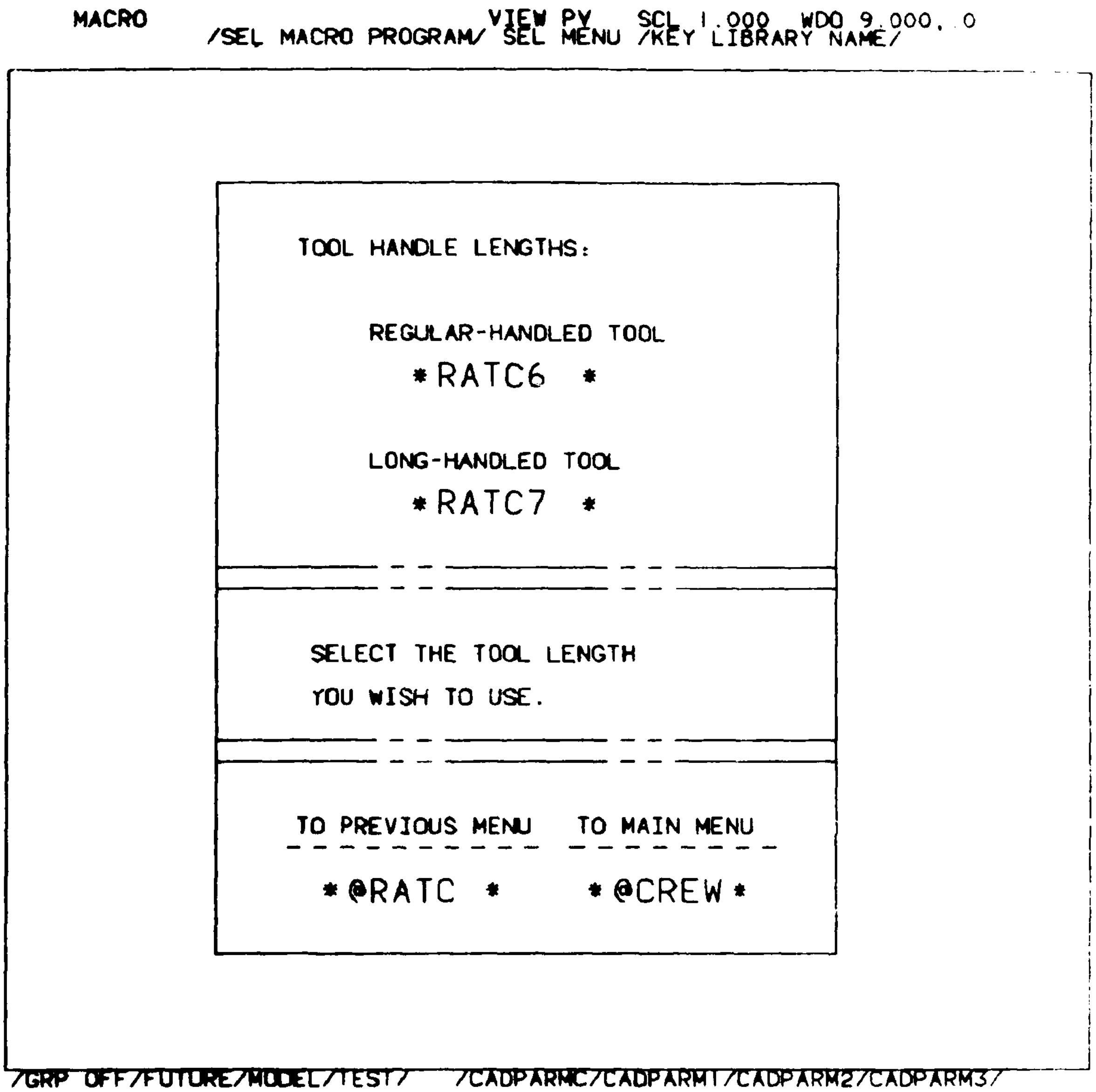


Figure 3.8. Tool Handle Length Selection Menu for Ratchet Wrenches.

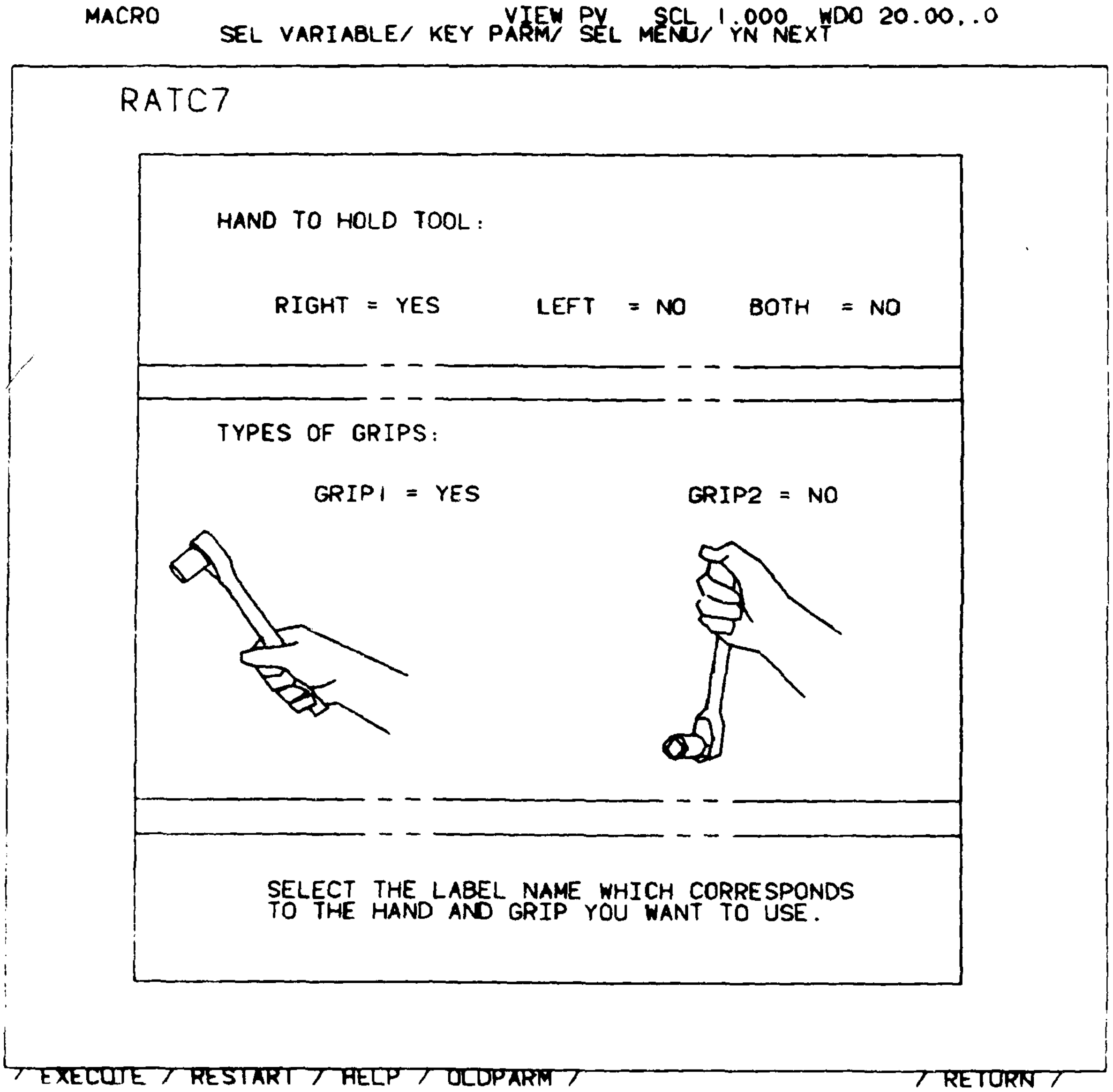


Figure 3.9. Hand and Grip Type Selection Menu for Ratchet Wrenches.

- Choose both hands by selecting **BOTH**

EXAMPLE: Select **LEFT**

RESULT: RIGHT and BOTH = NO, and LEFT = YES

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP</u> YOU WANT TO USE (prompt appears in the lower quarter of window)

ACTION: Select the grip type to be used in the analysis (see Figure 3.9). There will be separate menus for the grip types for the different tools. The different grip types have a value of YES or NO. The most commonly used grip type for the particular tool is the default and will appear with = YES when the menu appears initially.

- Accept the default grip (**GRIP1**)

<u>OR:</u>

- Choose the alternate grip by selecting **GRIP2**

EXAMPLE: Select **GRIP2**

RESULT: GRIP1 = NO and GRIP2 = YES.

When the user is satisfied with the tool definition and grip selections, he/she may continue the tool analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM/ <u>SEL MENU</u> / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will complete Tool and Grip

Definition, and will allow user to continue to the next step, tool orientation.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select desired extension length from lengths presented at bottom of window. If SPEEDHANDLE is selected, no extension lengths will be chosen.

EXAMPLE: Select **6"**

RESULT: Same prompt, but new bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select desired socket type from bottom menu.

NOTE: If the torque wrench or speedhandle is the tool type selected, then the socket type selections are: Regular, Deep, and Hex Drive. The universal joint is not included because it distorts accuracy of torque See Figure D.9 for a photograph of the various sockets.

- Select **/REGULAR/** to display a regular socket attached to the tool

OR:

- Select **/DEEP/** to display a socket with a deep bolt opening

OR:

- Select **/HEXDRV/** to display a socket to which a six-sided prong is attached.

OR:

- Select **/UNIVERSAL/** to display a socket similar to a regular socket, but is hinged.

EXAMPLE: Select **/REGULAR/**

RESULT: New prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE HEAD POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the location of the head point (center point of the bolt head) of the attach vector by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector.

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the tail point (point which determines the bolt direction) of the attach vector (to determine the direction of the bolt axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the orientation of the bolt axis

<u>OR:</u>

- Key in the X,Y,Z coordinates which define the orientation of the bolt axis **<CR>**

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE DIRECTION OF TOOL HANDLE</u> (prompt appears at top of window)

ACTION: Define the point that determines the direction that the tool handle points away from the bolt by selecting an existing 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing point in the drawing

<u>OR:</u>

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**

EXAMPLE: Key in **35, 170, 40 <CR>**

RESULT: Values keyed in (35, 170, 40) appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used during the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

<u>OR:</u>

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

<u>OR:</u>

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

<u>OR:</u>

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains the same, but a new bottom menu appears.

PROMPT: SEL MENU / YN REJECT / <u>INDICATE CENTER OF PLOT</u>

(prompt appears at bottom of window)

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen. If the tool type selected is the breaker bar or the speed handle, the user is not prompted to define a center of plot point, because there are no strength-related data to be displayed.

RESULT: New prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

<u>OR:</u>

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, attached to the point of attachment, in his hand A "TASK COMPLETED" message appears in the upper

left-hand corner of the window. The strength table is also displayed for ratchet and torque wrenches. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.10 diagrams the flow of actions necessary to execute a tool analysis for wrenches with sockets.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu, <u>or</u> select **@RATC** to return to the Bolt Diameter Selection menu for ratchet wrenches.

3.1.3 <u>Nutdriver</u>

For this example, the sequence of prompts to define the size of the nutdriver and its location in the drawing follow.

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE (prompt appears in lower third of window)

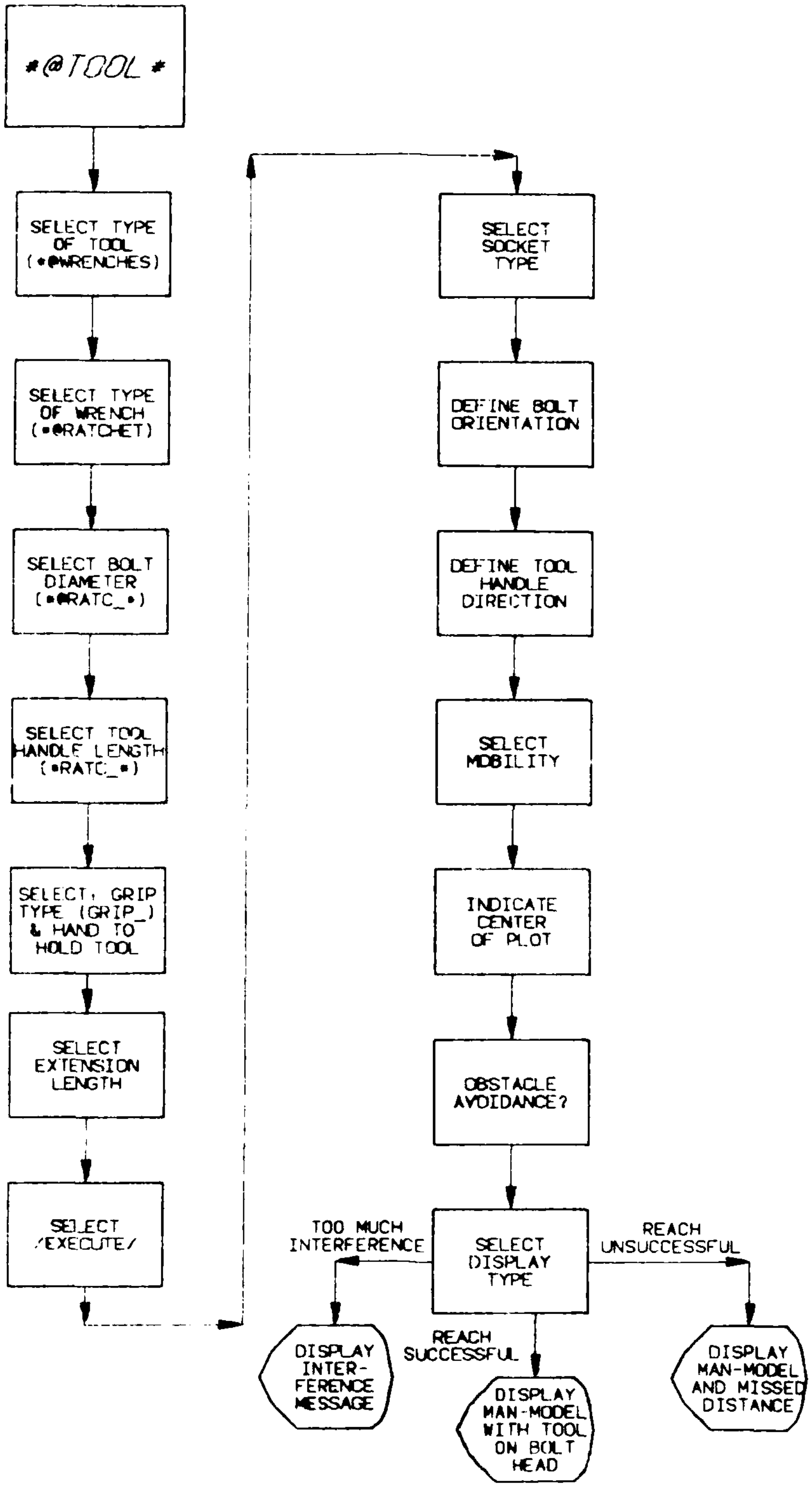


Figure 3.10. Tool Analysis Flow Diagram for Wrenches With Sockets.

ACTION: Select the type of tool to be used in the analysis (see Appendix D for a discussion of hand tools).

EXAMPLE: Select ***@NUTDRIVER**

RESULT: Bolt Diameter Selection menu appears (Figure 3.11).

PROMPT: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WISH TO USE (prompt appears in center of window)

ACTION: Select the abbreviation corresponding to the bolt diameter to be used in the analysis (Figure 3.11).

EXAMPLE: Select ***NUTDR1***

RESULT: Hand and Grip Type Selection menu appears (Figure 3.12).

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE (prompt appears on lower third of window)

ACTION: Select which hand will hold the tool in the analysis (Figure 3.12). The most commonly used hand (RIGHT) is the default and will appear with YES when the menu appears initially

- Accept the default hand (**RIGHT**)

<u>OR:</u>

- Choose the left hand by selecting **LEFT**

EXAMPLE: Select **LEFT**

RESULT: RIGHT = NO, and LEFT = YES.

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP</u> YOU WANT TO USE (prompt appears at bottom third of window)

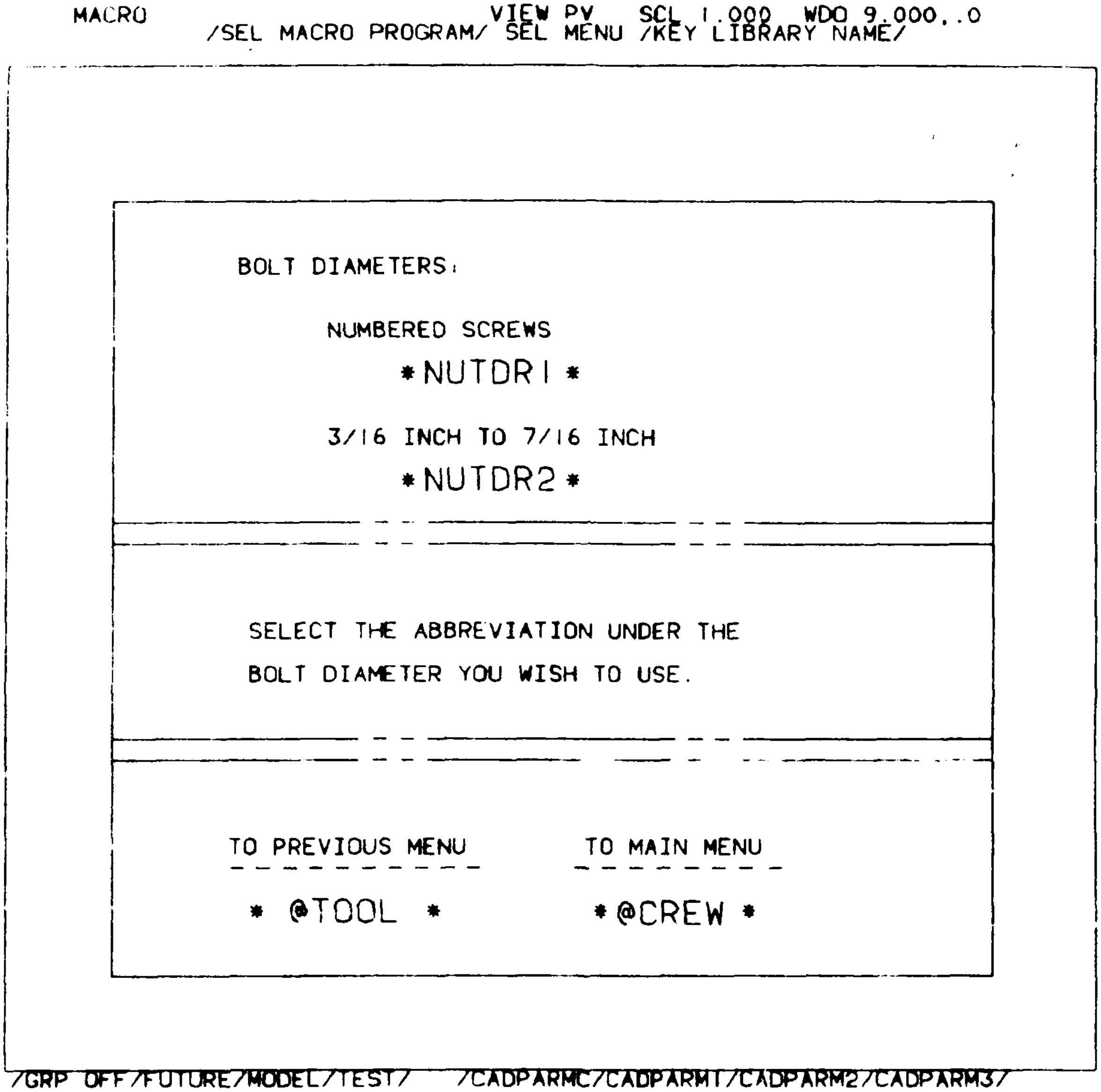


Figure 3.11. Bolt Diameter Selection Menu for Nutdrivers.

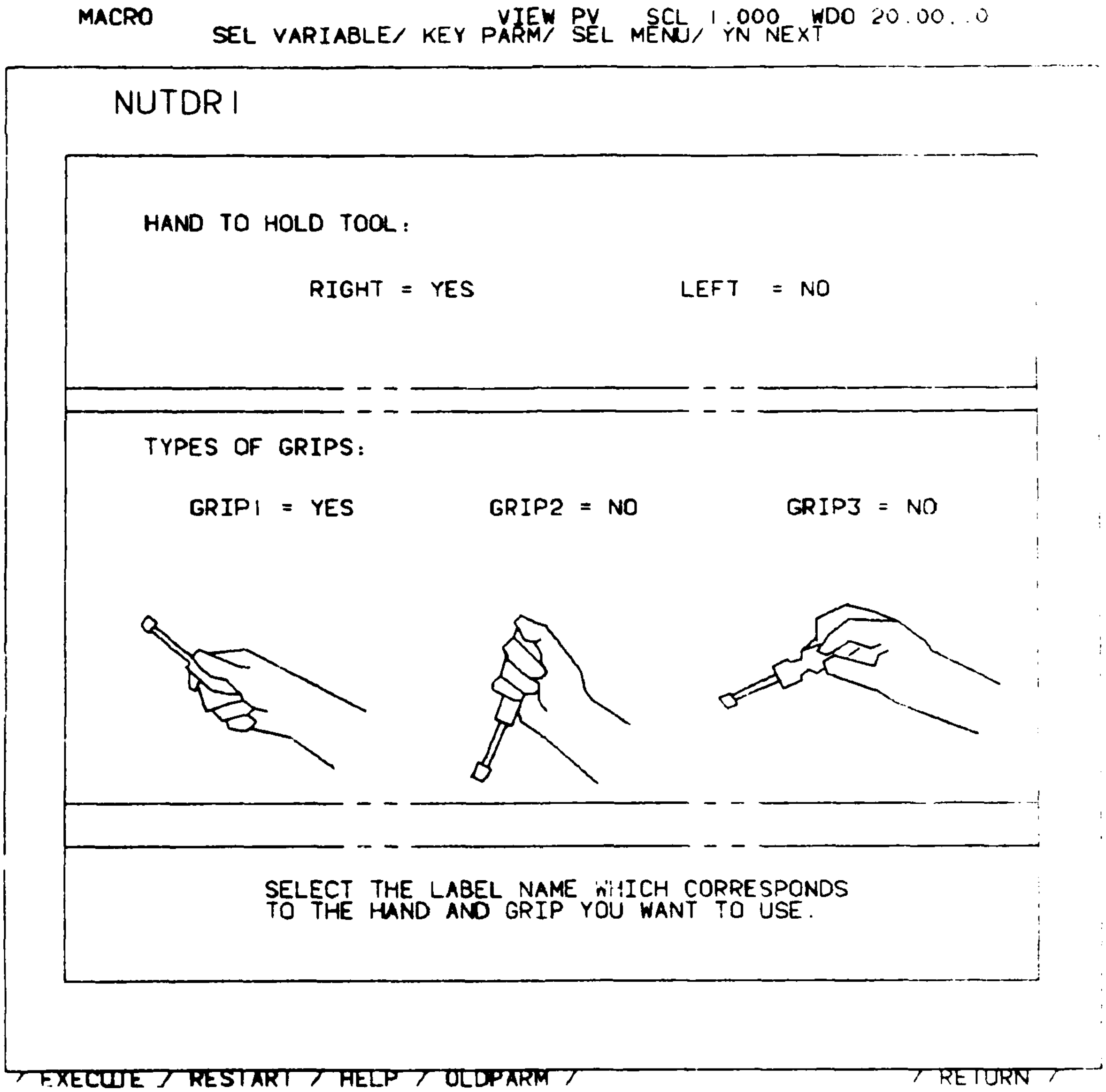


Figure 3.12. Hand and Grip Type Selection Menu for Nutdrivers.

ACTION: Select the grip type to be used in the analysis (Figure 3.12). There will be separate menus for the grip types for different tools. The different grip types have a value of YES or NO. The most commonly used grip type for the particular tool is the default and will appear with YES when the menu appears initially.

- Accept the default grip (**GRIP1**)

<u>OR:</u>

- Choose alternate grip by selecting **GRIP2**

<u>OR:</u>

- Choose alternate grip by selecting **GRIP3**

EXAMPLE: Select **GRIP2**

RESULT: GRIP1 and GRIP3 = NO, and GRIP2 = YES.

When the user is satisfied with the tool definition and grip selections, he/she may continue the tool analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT (prompt appears at top of window)

ACTION: Select choice from bottom menu. Selecting **/EXECUTE/** will complete Tool and Grip Definition and will allow user to continue to the next step, Tool Orientation.

EXAMPLE: Select **/EXECUTE/**

RESULT: New prompt appears on screen.

PROMPT: SEL MENU / YN REJECT / DEFINE HEAD POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the location of the head point of the attach vector (center point of the nut) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the tail point (point which determines the nut direction) of the attach vector (to determine the direction of the bolt axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point. This point also determines the direction from which the tool will be attached.

- Select an existing 3-D point to define the orientation of the bolt axis

OR:

- Key in the X,Y,Z coordinates which define the orientation of the bolt axis **<CR>**

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used during the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

<u>OR:</u>

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

<u>OR:</u>

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

<u>OR:</u>

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movements

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains same, but new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis: execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/NO OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: New prompt appears.

PROMPT: YN SAME/SEL MENU (prompt appears at top of window)

ACTION: Select **/EXECUTE/** from the menu at bottom of window

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool,

attached to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.13 diagrams the flow of actions necessary to execute a tool analysis for nutdrivers.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu <u>or</u> select **@TOOL** to return to the Tool Selection menu.

3.1.4 <u>Screwdrivers</u>

This classification of tools includes both regular screwdrivers and offset screwdrivers. For this example, a regular screwdriver was selected from the Tool Selection menu (**@TOOL**).

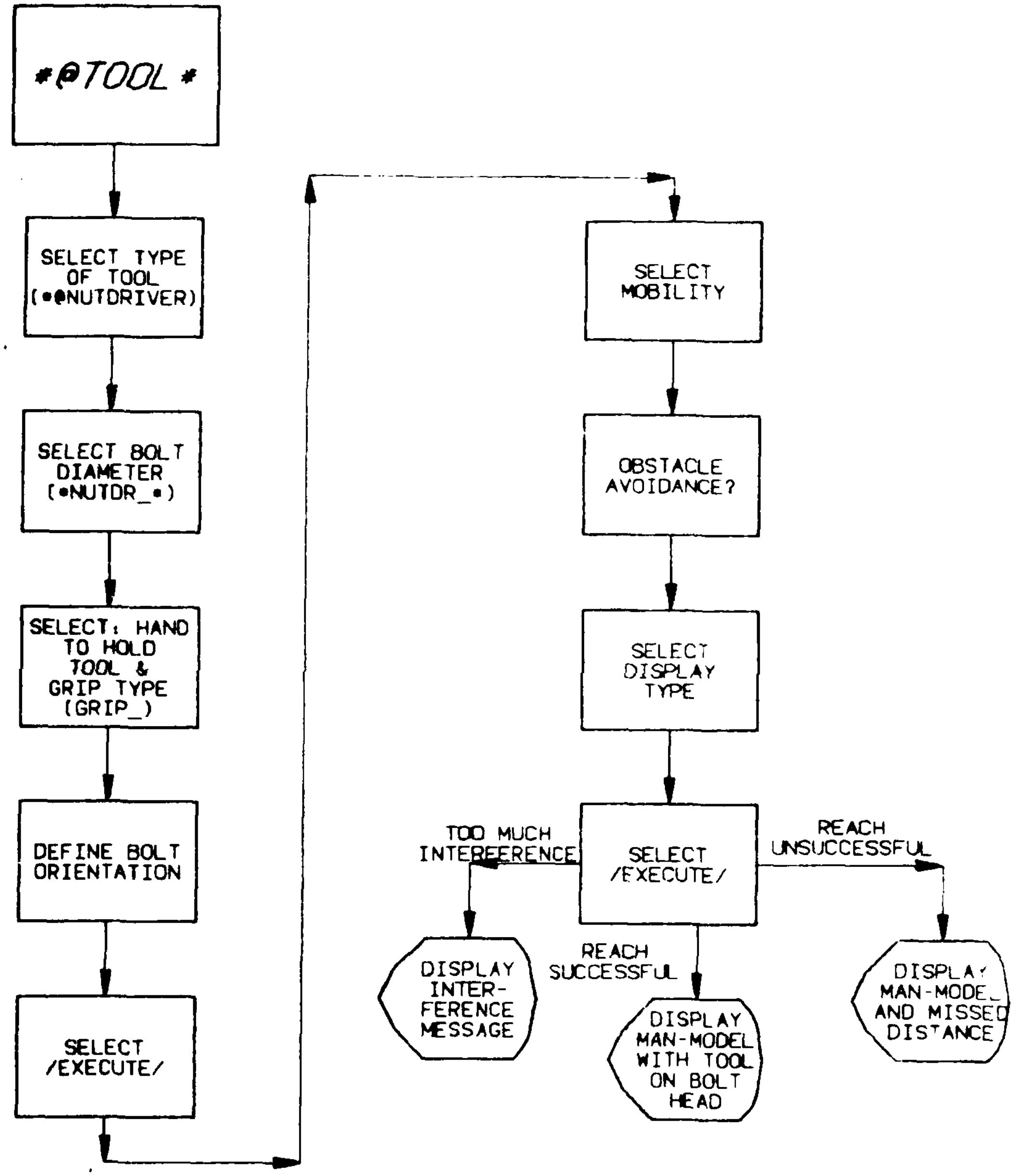


Figure 3.13. Tool Analysis Flow Diagram for Nutdrivers.

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the type of tool to be used in the analysis (see Appendix D for a discussion of hand tools)

EXAMPLE: Select ***@SCREWDRIVER**

RESULT: Screwdriver Selection menu appears (Figure 3.14).

PROMPT: SELECT THE TYPE OF SCREWDRIVER YOU WISH TO USE (prompt appears in lower third of screen)

ACTION: Select the type of screwdriver to be used in the analysis (see Figure 3.15)

EXAMPLE: Select ***@REGULAR**

RESULT: Blade Length Selection menu appears (Figure 3.15).

PROMPT: SELECT THE ABBREVIATION UNDER THE BLADE LENGTH YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the abbreviation corresponding to the screwdriver blade length to be used in the analysis (see Figure 3.14).

EXAMPLE: Select ***SCRDV2***

RESULT: Hand and Grip Type Selection menu appears (Figure 3.16).

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE (prompt appears on lower third of window)

ACTION: Select which hand will hold the tool in the analysis (see Figure 3.16). The most commonly used hand (RIGHT) is the default and will appear with YES when the menu appears initially.

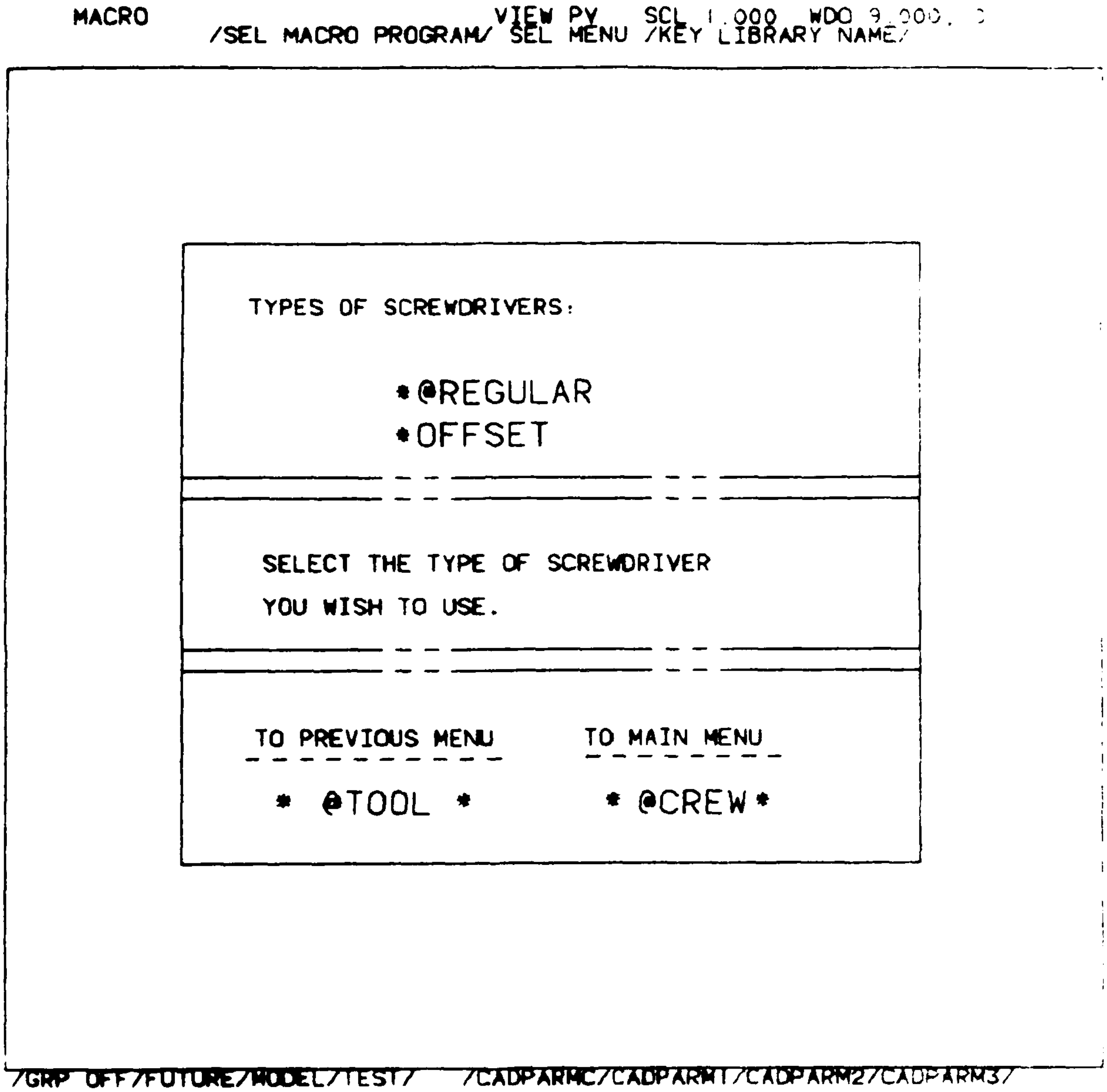


Figure 3.14. Screwdriver Selection Menu.

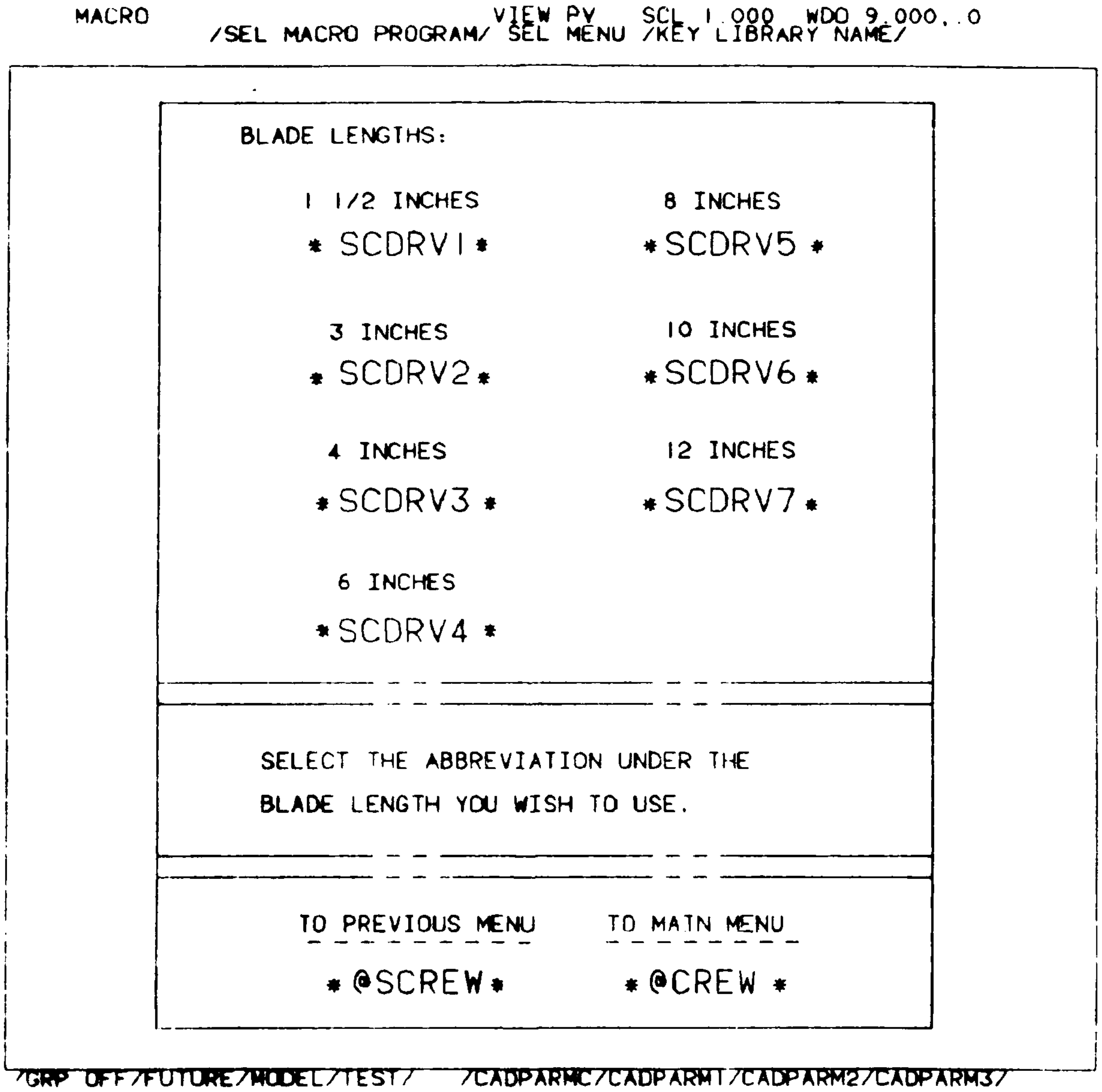


Figure 3.15. Blade Length Selection Menu.

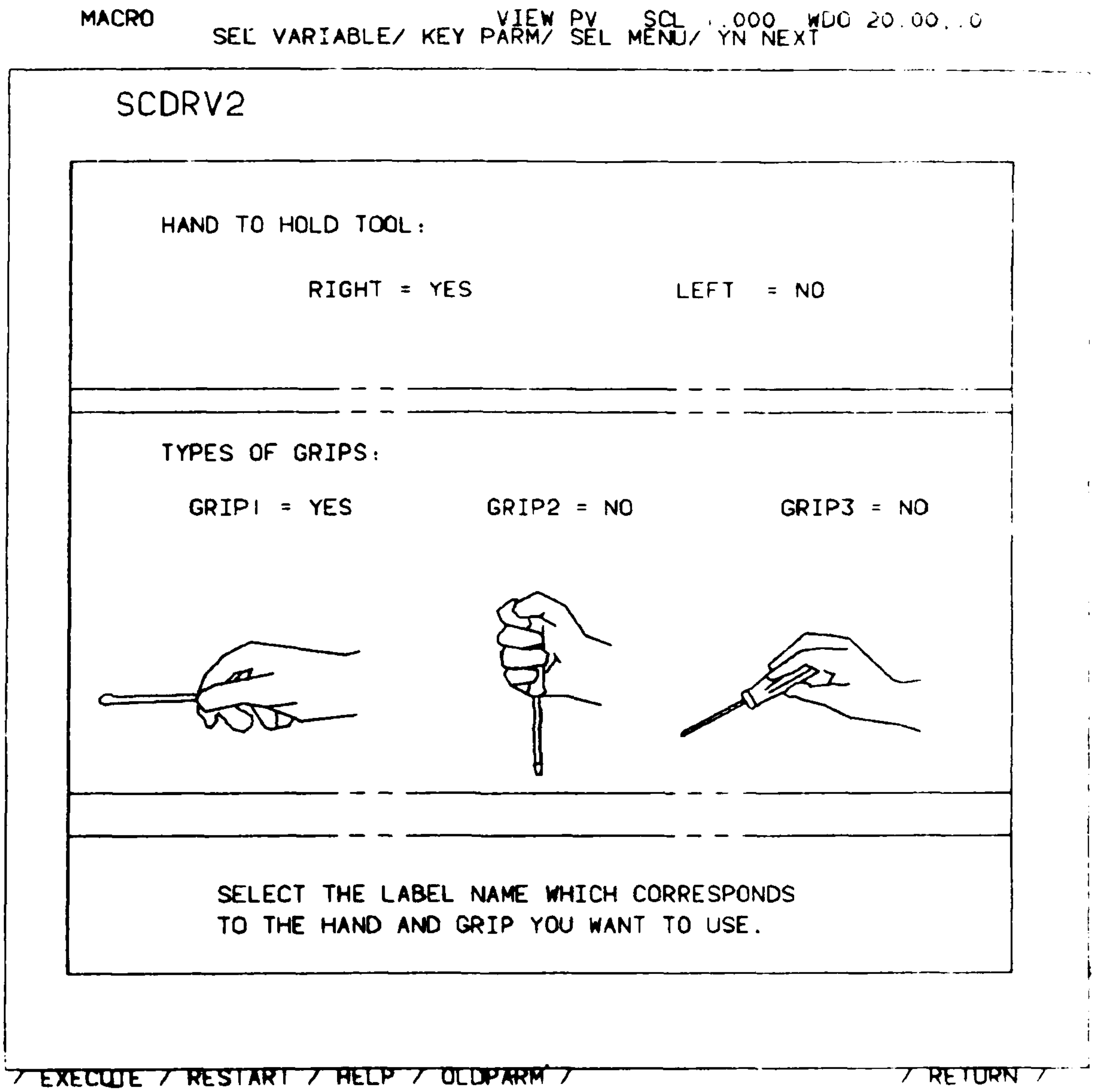


Figure 3.16. Hand and Grip Type Selection Menu for Regular Screwdrivers.

- Accept the default hand (**RIGHT**)

OR:

- Choose the left hand by selecting **LEFT**

EXAMPLE: Select **LEFT**

RESULT: RIGHT = NO, and LEFT = YES.

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE (prompt appears on the lower third of window)

ACTION: Select the grip type to be used in the analysis (see Figure 3.16). There will be separate menus for the grip types for the different screwdrivers. The different grip types have a value of YES or NO. The most commonly used grip type for the particular screwdriver is the default and will appear with YES when the menu appears initially.

- Accept the default grip (**GRIP1**)

OR:

- Choose alternate grip by selecting **GRIP2**

OR:

- Choose alternate grip by selecting **GRIP3**

EXAMPLE: Select **GRIP2**

RESULT: GRIP1 and GRIP3 = NO, and GRIP2 = YES.

When the user is satisfied with the tool definition and grip selection menu, he/she may continue the tool analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 3 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / <u>SEL MENU</u>/ YN NEXT

(prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will complete tool and grip definition and allow continuance of the next step, tool orientation.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE HEAD POINT OF ATTACH VECTOR</u> (prompt appears at top of window)

ACTION: Define the location of the head point of the attach vector (screw or point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing 3-D point to define the location of head point of attach vector

<u>OR:</u>

- Key in the X,Y,Z coordinates of the location of head point of attach vector <CR>

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE TAIL POINT OF ATTACH VECTOR</u> (prompt appears at top of window)

ACTION: Define the tail point of the attach vector (to determine the direction of the screw axis) by

selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing 3-D point to define the orientation of the bolt axis

OR:

- Key in the X,Y,Z coordinates which define the orientation of the screw axis **<CR>**

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEI MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used during the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

OR:

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

OR:

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

OR:

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains the same, but a new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appear

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: New bottom menu appears

PROMPT: YN SAME / SEL MENU (prompt appears at top of window)

ACTION: Select **/EXECUTE/** from bottom menu

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.17 diagrams the flow of actions necessary to execute a tool analysis for regular screwdrivers.

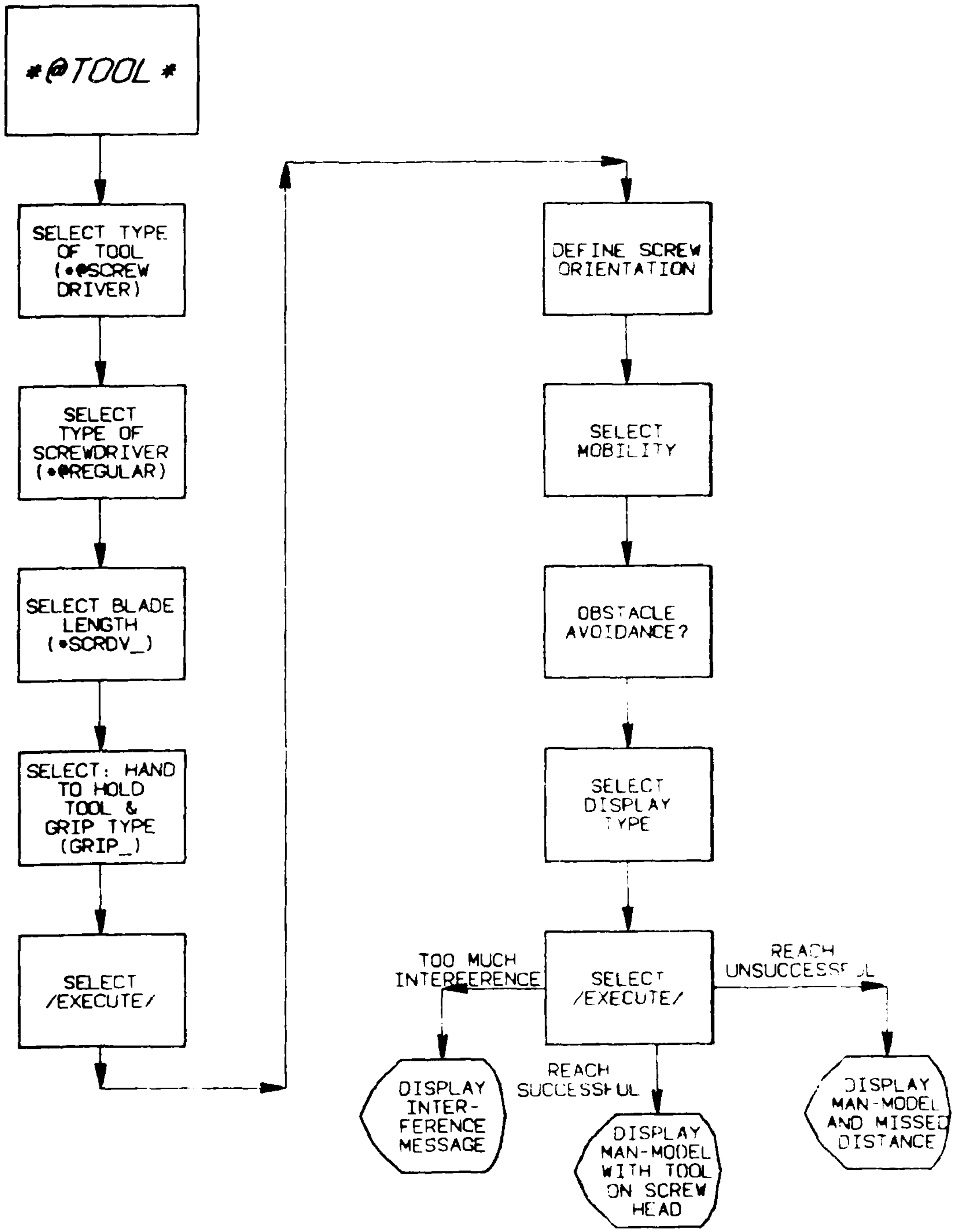


Figure 3.17. Tool Analysis Flow Diagram for Regular Screwdrivers.

To continue the analysis, the user selects **/MENU 1/** from bottom of screen and then selects **@CREW** to return to CREW CHIEF Main Programs menu <u>or</u> selects **@SCREW** to return to the Screwdriver Selection menu.

3.1.5 <u>Pliers</u>

This category of tools includes the following pliers: combination, needle nose, safety wire, adjustable joint, and wire cutters. Since all types of pliers follow the same sequence of prompts to define their orientation in the work space, the combination pliers will be used as an example. For this example, begin by selecting the Tool Selection menu (**@TOOL**).

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the type of tool to be used in the analysis (see Appendix D for a discussion of hand tools)

EXAMPLE: Select ***@PLIERS***

RESULT: Plier selection menu appears (Figure 3.18)

PROMPT: SELECT THE TYPE OF PLIERS YOU WISH TO USE (prompt appears in middle third of window)

ACTION: Select the type of pliers to be used in the analysis (see Figure 3.18)

EXAMPLE: Select ***COMBINATION***

RESULT: The Hand and Grip Type Selection menu appears (Figure 3.19)

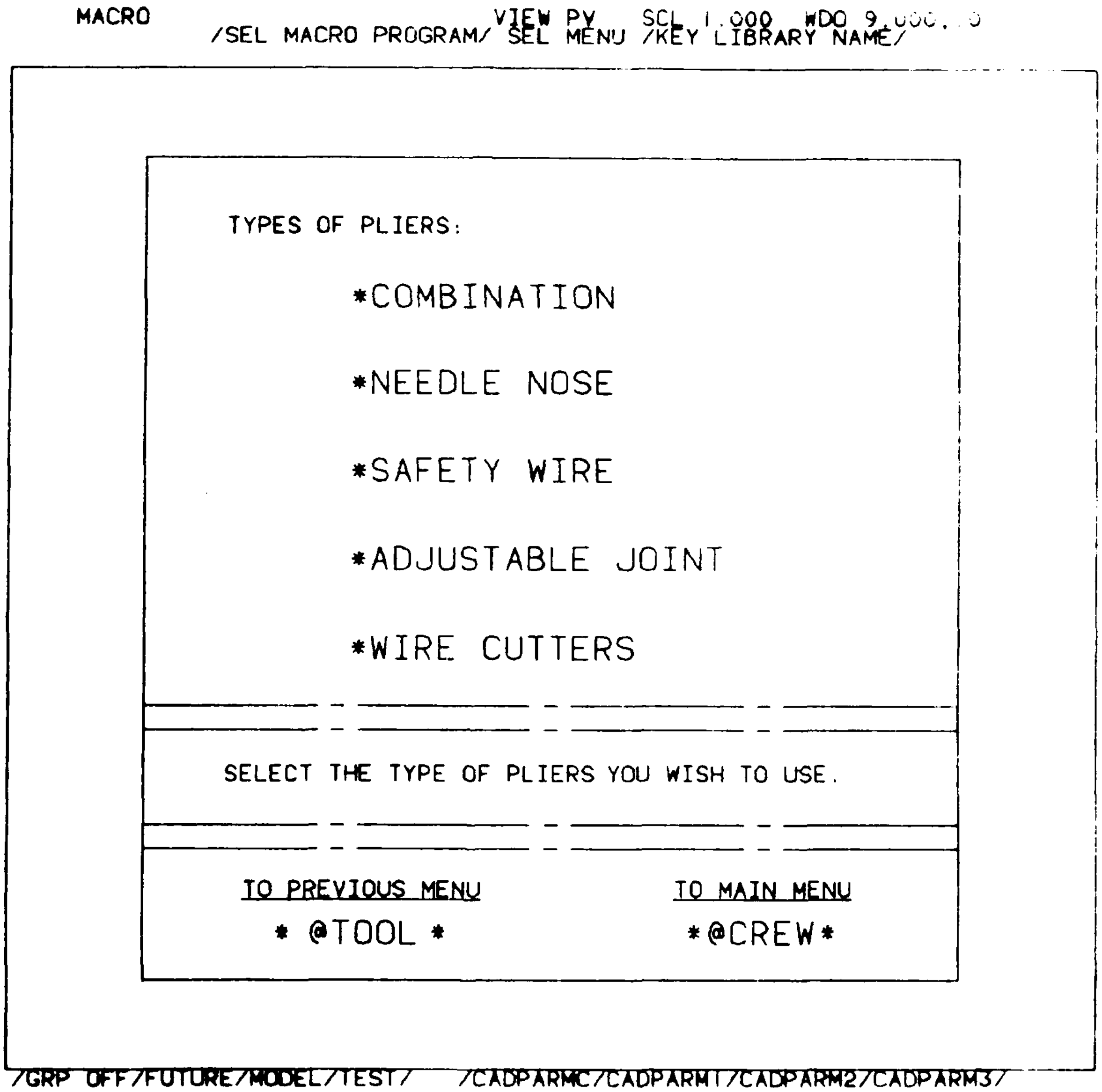


Figure 3.18. Pliers Selection Menu.

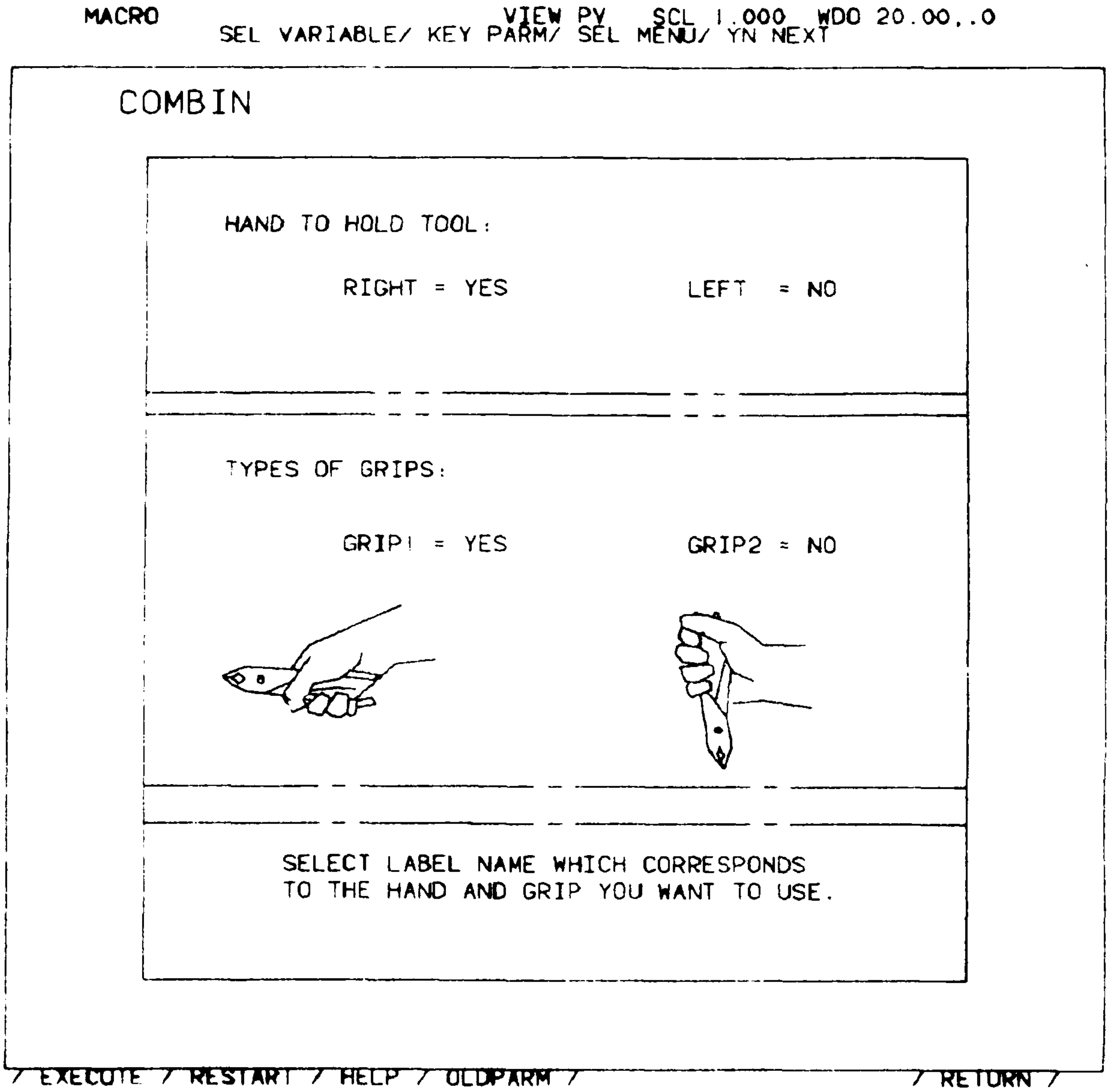


Figure 3.19. Hand and Grip Type Selection Menu for Combination Pliers.

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE (prompt appears in lower quarter of window)

ACTION: Select which hand will hold the tool in the analysis (see Figure 3.19). The most commonly used hand (RIGHT) is the default and will appear with YES when the menu appears initially.

- Accept the default hand **(RIGHT)**

OR:

- Choose the left hand by selecting **LEFT**

EXAMPLE: Select **LEFT**

RESULT: RIGHT = NO, and LEFT = YES

PROMPT: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE (prompt appears in lower quarter of window)

ACTION: Select the grip type to be used in the analysis (see Figure 3.19). There will be separate menus for different tools. The different grip types have a value of YES or NO. The most commonly used grip type for the particular tool is the default and will appear with YES when the menu appears initially

- Accept the default grip (**GRIP1**)

OR:

- Choose the alternate grip by selecting **GRIP2**

EXAMPLE: Select **GRIP2**

RESULT: GRIP1 = NO and GRIP2 = YES

When the user is satisfied with the tool definition and grip selections, he/she may continue the tool analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will complete Tool and Grip Definition and will allow user to continue to the next step, Tool Orientation

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE HEAD POINT OF ATTACH VECTOR</u> (prompt appears at top of window)

ACTION: Define the location of the head point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing 3-D point to define the location of head point of attach vector

<u>OR:</u>

- Key in the X,Y,Z coordinates of the location of head point of attach vector **<CR>**

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the tail point of the attach vector (to determine the direction of the point of attachment axis) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing 3-D point to define the tail point of attach vector

OR:

- Key in the X,Y,Z coordinates which define the tail point of attach vector **<CR>**

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE DIRECTION OF TOOL HANDLE (prompt appears at top of window)

ACTION: Define the direction that the tool handle points away from the point of attachment

- Select an existing point in the drawing

OR:

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**

EXAMPLE: Key in **35, 170, 40 <CR>**

RESULT: Values keyed in (35, 170, 40) appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used during the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

OR:

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

OR:

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

OR:

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains the same, but a new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: New prompt and new menu appear.

PROMPT: YN SAME / SEL MENU (prompt appears at top of window)

ACTION: Select **/EXECUTE/** from bottom menu

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper

left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.20 diagrams the flow of actions necessary to execute a tool analysis for pliers.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu <u>or</u> select **@TOOL** to return to Tool Selection menu.

3.1.6 Miscellaneous Tools

This classification of tools includes the following: hammer, chisel/hammer, file, scraper, hacksaw, drill, and sander. For this example, begin with the Tool Selection menu (**@TOOL**).

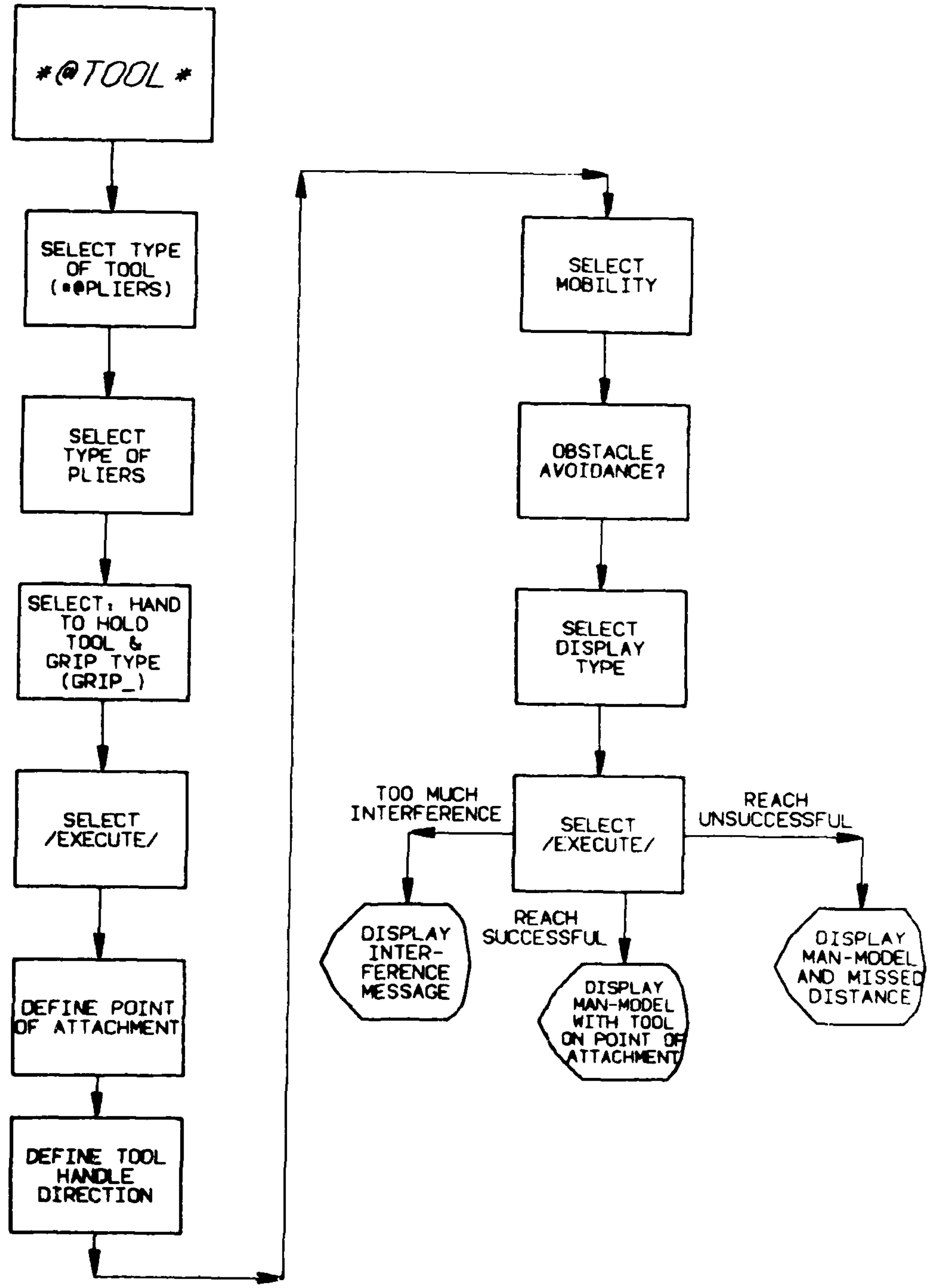


Figure 3.20. Tool Analysis Flow Diagram for Pliers.

PROMPT: SELECT THE TYPE OF TOOL YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the type of tool to be used in the analysis (Figure 3.2). (See Appendix D for a discussion of hand tools.)

EXAMPLE: Select ***HAMMER**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select in which hand the tool will be positioned from the bottom menu. If hammer, chisel/hammer, or scraper is the tool selected for the analysis, it may be placed in either the right hand or in the left hand. If file, drill, or hacksaw is the tool selected for the analysis, it may be placed in the right hand, the left hand, or both hands. No selection for hand to hold tool is given for the sander because both hands are automatically used with it. The most commonly used hand (RIGHT) is the default and will appear with YES when the menu appears initially.

- Select **/RIGHT/** to position the tool in the right hand

<u>OR:</u>

- Select **/LEFT/** to position the tool in the left hand

EXAMPLE: Select **/RIGHT/**

RESULT: /RIGHT/ is underscored and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE HEAD POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the location of the nead point of the attach vector (point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point.

- Select an existing 3-D point to define the location of head point of attach vector

OR:

- Key in the X,Y,Z coordinates of the location of head point of attach vector <CR>

EXAMPLE: Key in **27, 163, 40 <CR>**

RESULT: Values keyed in (27, 163, 40) appear at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define the tail point of attach vector (to determine the direction of the point of attachment) by selecting an existing target 3-D point or by keying in the X,Y,Z coordinates of the point

- Select an existing 3-D point to define the tail point of attach vector

OR:

- Key in the X,Y,Z coordinates which define the tail point of attach vector <CR>

EXAMPLE: Key in **35, 163, 40 <CR>**

RESULT: Values keyed in (35, 163, 40) appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE DIRECTION OF TOOL HANDLE</u> (prompt appears at top of window)

ACTION: Define the direction that the tool handle points away from the point of attachment

- Select an existing point in the drawing

<u>OR:</u>

- Key in the X,Y,Z coordinates of the tool handle direction point **<CR>**

EXAMPLE: Key in **35, 170, 40 <CR>**

RESULT: Values keyed in (35, 170, 40), appear at top left-hand side of window and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

<u>OR:</u>

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

<u>OR:</u>

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

<u>OR:</u>

- Select **/NONE/** when user wishes to perform strength analysis in the displayed posture only, not allowing any movement

EXAMPLE: Select **/UPR BODY/**

RESULT: Prompt remains the same, but a new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

<u>OR:</u>

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire frame man-model

<u>OR:</u>

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

<u>OR:</u>

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: A new prompt and new menu appear.

PROMPT: YN SAME / <u>SEL MENU</u> (prompt appears at top of window)

ACTION: Select **/EXECUTE/** from bottom menu

RESULT: If the man-model is able to reach the point of attachment, the man-model appears superimposed in the drawing as a wire-frame model with the tool, connected to the point of attachment, in his hand. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model/tool and the point of attachment is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model/tool's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.21 diagrams the flow of actions necessary to execute a tool analysis for all Miscellaneous Tools.

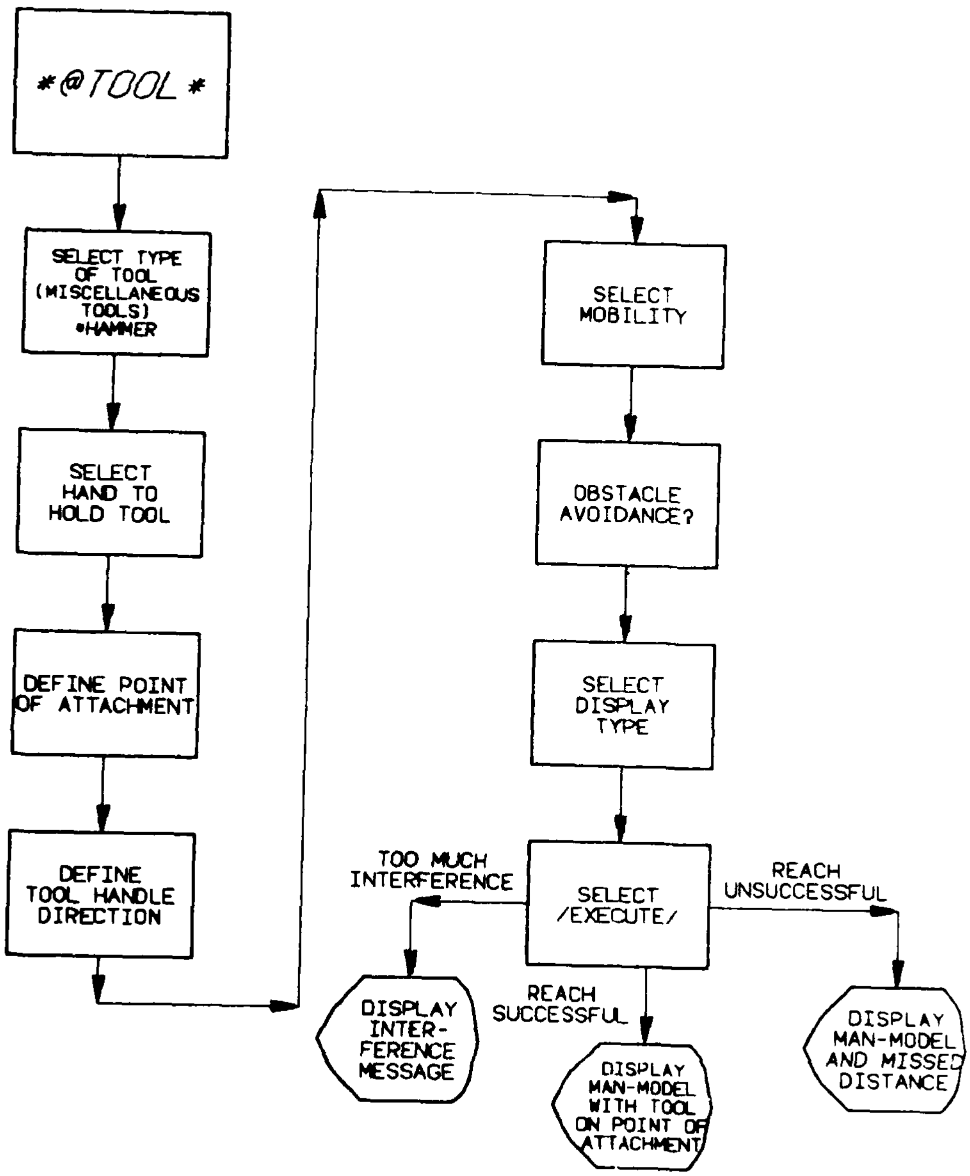


Figure 3.21. Tool Analysis Flow Diagram for Miscellaneous Tools.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu.

3.2 MATERIALS HANDLING ANALYSIS FUNCTION (@MMH)

This function will be used for analysis pertaining to the handling of objects in the workplace. The function will consider such factors as the ability to do one- and two-handed reaches to an object, and strength capabilities related to lift, move, and position of objects in the location of work relative to the man-model's position and posture, and to the location of the object in the workplace.

To use the Materials Handling function, key in **@CREW** <CR>, which will cause the CREW CHIEF Main Programs menu to appear on the screen (see Figure 1.3). Selecting **@TSKAN** causes the CREW CHIEF Task Analyses Function menu to appear (Figure 3.1).

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in the lower third of window)

ACTION: Select the abbreviation under Task Analysis function to be performed (Figure 3.1)

EXAMPLE: Select ***@MMH***

RESULT: The Materials Handling Task menu is displayed (see Figure 3.22).

3.2.1 <u>CARRY</u>

CARRY is the first of the eight materials handling tasks and is selected when the man-model transports an object while supporting the object's weight from one horizontal location to another. For this example, begin by selecting the Materials Handling Task menu (**@MMH**).

MACRO VIEW PV SCL 1.000 WDO 13.08,.0
/SEL MACRO PROGRAM/ SEL MENU /KEY LIBRARY NAME/

MATERIALS HANDLING TASKS:

CARRY TRANSPORT OBJECT WHILE SUPPORTING ITS WEIGHT FROM ONE HORIZONTAL LOCATION TO ANOTHER.

HOLD SUPPORTING WEIGHT OF OBJECT AT A REQUIRED HEIGHT.

LIFT TRANSPORT OBJECT FROM ONE VERTICAL LOCATION TO ANOTHER.

PUSH MOVING OBJECT AWAY FROM BODY IN HORIZONTAL DIRECTION WITHOUT SUPPORTING THE WEIGHT OF OBJECT.

PULL MOVING OBJECT TOWARD BODY IN A HORIZONTAL DIRECTION WITHOUT SUPPORTING THE WEIGHT OF OBJECT.

TURN ROTATING OBJECT OR HANDLE ABOUT AN AXIS.

GRASP GET HOLD OF OBJECT OR HANDLE WITHOUT MOVING IT.

REACH TRANSPORT EMPTY HANDS TO A DIFFERENT LOCATION.

SELECT NAME OF TASK YOU WISH TO PERFORM

TO PREVIOUS MENU *@TSKAN*

TO MAIN MENU *@CREW*

/GRP OFF/FUTURE/MODEL/TEST/ /CADPARMC/CADPARM1/CADPARM2/CADPARM3/

Figure 3.22. Materials Handling Tasks Menu.

PROMPT: SELECT NAME OF TASK YOU WISH TO PERFORM (prompt appears in lower third of window)

ACTION: Select the name of the task to use for the analysis (see Figure 3.22)

EXAMPLE: Select ***CARRY***

RESULT: New prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the handle choices from the bottom menu to determine whether or not handles will be used

- Select **/NO HANDLES/** to indicate that no handles are to be used during the CARRY task

OR:

- Select **/HANDLES <CRAWL POSTURE ONLY>/** to indicate that handles are to be used during the CARRY task. Note that the CARRY Task will automatically change the current man-model posture based on the input ceiling height. The man-model will only perform CARRY Tasks with handles when the ceiling height is below 50 percent of the current man-model stature.

EXAMPLE: Select **/NO HANDLES/**

RESULT: /NO HANDLES/ is underscored and a new prompt appears.

If /HANDLES <CRAWL POSTURE ONLY>/ is chosen, the user would be prompted to SELECT NUMBER OF HANDLES to be used during the CARRY task. If the user selects /NO HANDLES/, as in the example, the following prompt will appear on the screen.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Key in or select the mode for defining the ceiling height.

- Choose **/SELECT/** to allow selection of an element from the screen

OR:

- Choose **KEY IN** to allow the ceiling height to be entered at the ANKB

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored and new prompt appears.

If /SELECT/ is chosen, the user would be prompted to SELECT CEILING HEIGHT from the screen. As a result of selecting **/KEY IN/**, as the example, the following prompt will appear on the screen.

PROMPT: SEL MENU/YN REJECT/<u>KEY IN CEILING HEIGHT</u>

ACTION: Key in value to represent ceiling height **<CR>**

EXAMPLE: Key in **80** **<CR>**

RESULT: 80 appears (top left corner) and new prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>KEY IN OBJECT HEIGHT</u> (prompt appears at top of window)

ACTION: Key in a value to represent the height of the object to be carried **<CR>**

EXAMPLE: Key in **12.34** **<CR>**

RESULT: 12.34 appears (top left corner) and new prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>KEY IN OBJECT WIDTH</u> (prompt appears at top of window)

ACTION: Key in a value to represent the width of the object to be carried <CR>

EXAMPLE: Key in **20.2 <CR>**

RESULT: 20.2 appears (top left corner) and new prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>KEY IN OBJECT DEPTH</u> (prompt appears at top of window)

ACTION: Key in a value to represent the depth of the object to be carried **<CR>**

EXAMPLE: Key in **18 <CR>**

RESULT: 18 appears (top left corner) and new prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u> (prompt appears at top of window)

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach

RESULT: A new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during CARRY analysis; execution time is increased

<u>OR:</u>

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/NO OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definition of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

<u>OR:</u>

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

<u>OR:</u>

- Select **/REPOSITION/** to display reposition view of man-model when repositioning is desired. (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to carry the object successfully, the man-model appears superimposed in the drawing as a wire-frame model holding the object in the final CARRY position, with its hands either on the object or on the handle(s). A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top left-hand corner of the window. If the reach is

unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand corner of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.23 diagrams the flow of actions necessary to execute a CARRY analysis.

To continue an analysis, select **/MENU 1/** from bottom menu to return to Materials Handling menu. To continue any other analysis, select **@TSKAN** to return to the Task Analysis menu or select **@CREW** to return to the CREW CHIEF Main Programs menu.

3.2.2 HOLD

HOLD is the second of the eight materials handling tasks, and is selected when the man-model supports the weight of an object at a required height. For this example, begin by selecting the Materials Handling Task menu (**@MMH**).

PROMPT: SELECT THE NAME OF TASK YOU WISH TO PERFORM (prompt appears in lower third of window)

ACTION: Select the name of the task to use for the analysis (see Figure 3.22)

EXAMPLE: Select ***HOLD***

RESULT: New prompt appears.

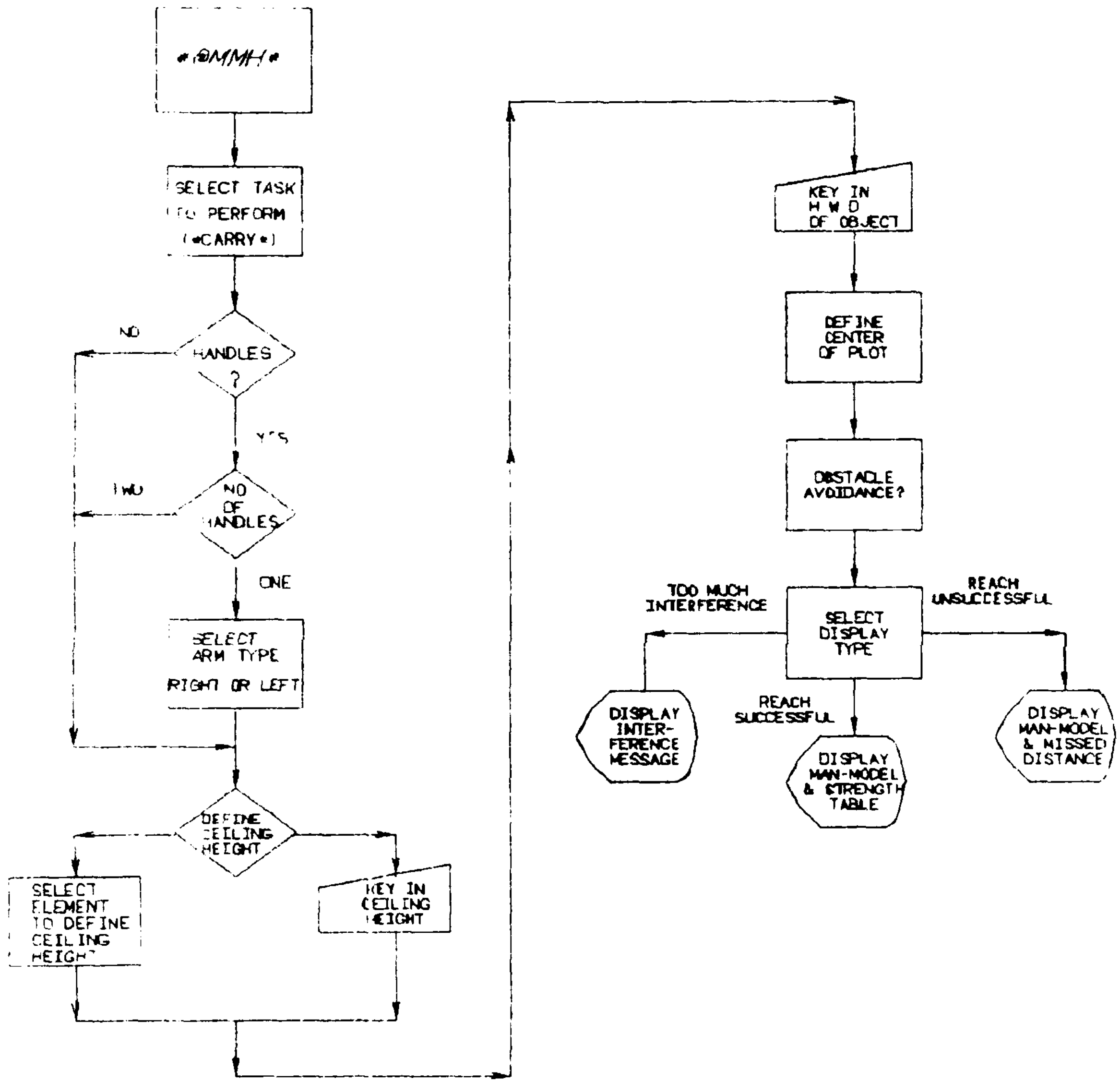


Figure 3.23. Materials Handling Analysis Flow Diagram for CARRY Task.

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HOLD TASK TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select which arm will hold the object in the analysis (see Figure 3.24). The most commonly used arm (LEFT) will have the value YES, and will be the default type.

- Accept the default arm type (**LEFT**) for HOLD Task

OR:

- Choose the right arm by selecting **RIGHT**

EXAMPLE: Select **RIGHT**

RESULT: LEFT = NO, and RIGHT = YES

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HOLD TASK TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.24). The most commonly used mobility (UPPER BODY) will have the value YES and will be the default mobility type.

- Accept the default mobility type (**UPPER BODY**)

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility

EXAMPLE: Select **FULL BODY**

RESULT: ARM/SHOULDER, UPPER BODY both = NO, and FULL BODY = YES

MACRO VIEW SCL 1.000 WDO 1.000,.0
SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

HOLD

ARM TYPES:

RIGHT = NO   LEFT = YES

TYPES OF MOBILITY:

ARM/ SHOULDER = NO   UPPER BODY = YES   FULL BODY = NO

TYPES OF HOLD TASKS:

AGAINST WALL = YES   AGAINST CEILING = NO

SELECT ARM TYPE, MOBILITY TYPE, AND
HOLD TASK TYPE YOU WISH TO USE.

**NOTE
DEFAULT ARM TYPE IS LEFT.
DEFAULT MOBILITY TYPE IS UPPER BODY.
DEFAULT HOLD TASK TYPE IS AGAINST WALL.

/ EXECUTE / RESTART / HELP / OLDPARM /   / RETURN /

Figure 3.24. Arm, Mobility, and Hold Task Type Selection Menu for HOLD Task.

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HOLD TASK TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select Hold Task Type to be used (see Figure 3.24). The most commonly used Hold Task Type (AGAINST WALL) will have the value YES and will be the default Hold Task Type.

- Accept the default Hold Task Type (**AGAINST WALL**)

OR:

- Choose **AGAINST CEILING**

EXAMPLE: Accept default **AGAINST WALL**

RESULT: AGAINST WALL = YES and AGAINST CEILING = NO

When the user is satisfied with the Arm, Mobility, and Hold Task Type selections, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will allow continuance of next step, to specify any barriers hampering the HOLD Task, object dimensions, and orientation in the design.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

If AGAINST CEILING is chosen as the Hold Task Type, the user would select a mode for defining the object (KEY IN or

SELECT). Choosing AGAINST CEILING also automatically defines the top of the object as the ceiling height (see Paragraph 9.2.1). As a result of selecting AGAINST WALL the following prompts will appear on the screen.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the barrier types from the bottom menu. This action will affect the strength values output at the completion of a successful task.

- Select /NONE/ to indicate a task which does not involve any obstructions which would keep the man-model from reaching in any direction or which would require the man-model to bend over due to obstacles.

<u>OR:</u>

- Select /VERTICAL/ to indicate man-model will stand approximately 15 inches or more away from the object due to obstacles in the man-model's reach path.

<u>OR:</u>

- Select /CEILING/ to indicate an overhead barrier. This barrier will cause the man-model to bend over to complete the task.

EXAMPLE: Select /CEILING/

RESULT: New prompt appears.

If /NONE/ or /VERTICAL/ is chosen, the user would be prompted to select the mode for defining the object (KEY-IN or

SELECT). (See Paragraph 9.2.2.2.) As a result of selecting **/CEILING/**, the following prompt will appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the mode for defining ceiling height

- Choose **/SELECT/** to indicate that a line segment will be selected to define the ceiling height.

<u>OR:</u>

- Select **/KEY IN/** to indicate the ceiling height will be keyed in

EXAMPLE: Choose **/SELECT/**

RESULT: /SELECT/ is underscored and a new prompt appears.

If the user selects /KEY IN/, the /KEY IN/ portion of the bottom menu is underscored and the user is prompted to key in the ceiling height. As a result of choosing **/SELECT/**, the following prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE CEILING HEIGHT</u> (prompt appears at top of window)

ACTION: Select a line segment in the drawing to define the ceiling height. The line segment selected will be used to define the ceiling height by taking the intersection of the line segment (which is extended as needed to find an intersection) with the plane that bisects the man-model into symmetric right and left halves. The vertical distance between this intersection point and the platform becomes the value of the ceiling height.

Note that it is possible that no intersection can be found and the user will be notified later.

EXAMPLE: Select a line segment which defines the ceiling height.

RESULT: A new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the mode (key in or select) for defining the dimensions (HEIGHT, WIDTH, and DEPTH) of the object to be held

- Choose **/SELECT/** to allow *selection of elements* from screen. The height and width selections will determine the attach plane and attach points of the object automatically for AGAINST WALL - Hold tasks. Similarly, the *width and depth* selection will determine the attach plane (i.e., CEILING) and attach points for AGAINST CEILING - Hold tasks.

OR:

- Choose **/KEY IN/** to allow dimensions to be entered at the ANKB.

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored and new prompt appears

If /SELECT/ is chosen, the user would be prompted to (1) SELECT OBJECT HEIGHT, (2) SELECT OBJECT WIDTH, (3) SELECT OBJECT DEPTH from the screen, and to (4) select any other elements that define the object. When these other elements have been defined, the user would select **/END/** from the bottom menu

(see Paragraph 9.2.2.2). If the user selects **/KEY IN/**, as in the example, the following prompt will appear on the screen.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT HEIGHT</u> (prompt appears at top of window)

ACTION: Key in a value to represent the height of the object to be held **<CR>**

EXAMPLE: Key in **10.31 <CR>**

RESULT: 10.31 appears at top left-hand corner of window and new prompt appears

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT WIDTH</u> (prompt appears at top of window)

ACTION: Key in a value representing the width of the object to be held **<CR>**

EXAMPLE: Key in **15 <CR>**

RESULT: 15 appears at top left-hand corner of screen and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT DEPTH</u> (prompt appears at top of window)

ACTION: Key in a value representing the depth of the object to be held **<CR>**

EXAMPLE: Key in **9.5 <CR>**

RESULT: 9.5 appears at top left-hand side of screen and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>SELECT LINE DEFINING HEIGHT DIRECTION</u> (prompt appears at top of window)

ACTION: Select an element from the screen which will be used to define the plane to which the object will be attached. Since the example uses AGAINST WALL - Hold task, the user must select a line which extends in the same direction as the height of the object.

RESULT: New prompt appears

PROMPT: SEL MENU / YN REJECT / SELECT LINE2 TO DEFINE ATTACH PLANE (prompt appears at top of window)

ACTION: Select element from screen which will be used to define the plane to which the object will be attached. Since this example is for an AGAINST WALL - Hold task, the user should select a line which lies on the wall (or mounting bracket). This line should not lie in the same direction as the line selected for the previous prompt. These lines determine an attach plane for the created object. The back face of the object will be placed flush against the plane (or a parallel plane) defined by these two lines. Note that this determines the directions of the width and depth dimensions of the object since the height direction has already been defined and the object is assumed rectilinear. (All dimensions are assumed to be perpendicular to each other.)

RESULT: New prompt appears

PROMPT: SEL MENU / YN REJECT / <u>DEFINE ATTACH POINT OF THE OBJECT</u> (prompt appears at top of window)

ACTION: Define a 3-D point to indicate where the center of the back face of the object will be placed on the attach plane (wall or bracket the object is to be held against).

- Select an existing 3-D point from the screen to determine the attach point of the object

<u>OR:</u>

- Key in the X,Y,Z coordinates **<CR>** to determine which face of the object will be attached to the attach plane

EXAMPLE: Key in **110.37, 25.80, 15.45 <CR>**

RESULT: The coordinates (110.37, 25.80, 15.45) appear in the top left-hand corner of the window and a new prompt appears

PROMPT: SEL MENU / YN REJECT / <u>INDICATE CENTER OF PLOT</u> (prompt appears at top of window)

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach

RESULT: A new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during REACH analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/NO OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but a new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to hold the object successfully, the man-model appears superimposed in the drawing as a wire-frame model holding the

object with its hands either on the object or on the handle(s) (in the final hold position). A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great or because there are barriers present, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand corner of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.25 diagrams the flow of actions necessary to execute a HOLD analysis.

To continue an analysis, select **/MENU 1/** from bottom menu to return to Materials Handling menu. To continue any other analysis, select **@TSKAN** to return to the Task Analysis menu or select **@CREW** to return to the CREW CHIEF Main Programs menu.

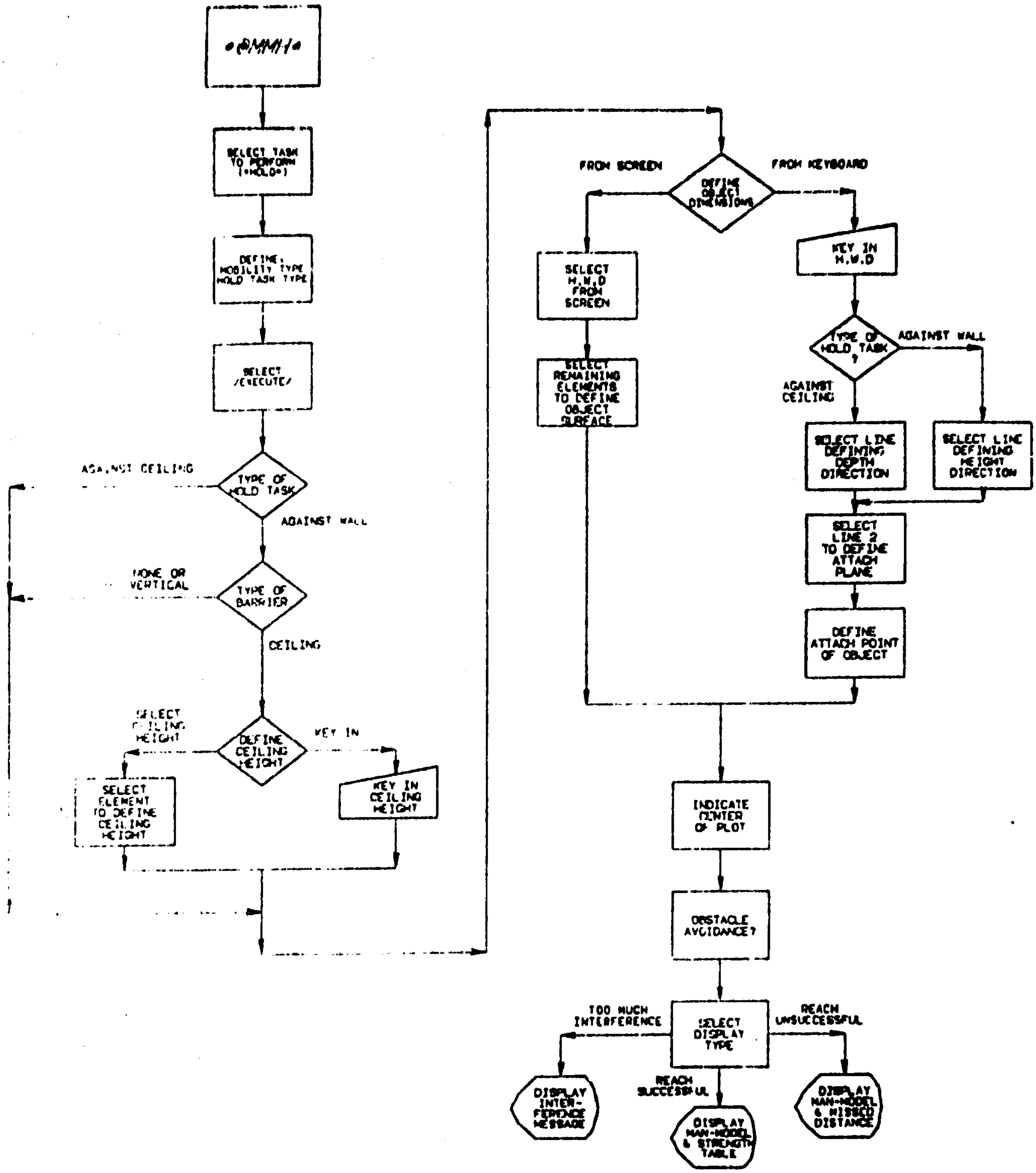


Figure 3.25. Materials Handling Analysis Flow Diagram for HOLD Task.

3.2.3 LIFT

LIFT is the third of the eight materials handling tasks, and is selected when the man-model transports an object from one vertical location to another. For this example, begin by selecting the Materials Handling Task menu (**@MMH**).

PROMPT: SELECT THE NAME OF TASK YOU WISH TO PERFORM (prompt appears in lower third of window)

ACTION: Select the name of the task to be used in the analysis (Figure 3.22)

EXAMPLE: Select ***LIFT***

RESULT: New prompts appear

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HANDLE TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select which arm will lift the object in the analysis (see Figure 3.26). The most commonly used arm (BOTH) will have the value YES, and will be the default type.

- Accept the default arm type (**BOTH**) for LIFT Task

OR:

- Choose the right arm by selecting **RIGHT**

OR:

- Choose the left arm by selecting **LEFT**

EXAMPLE: Select **RIGHT**

RESULT: LEFT and BOTH = NO, and RIGHT = YES

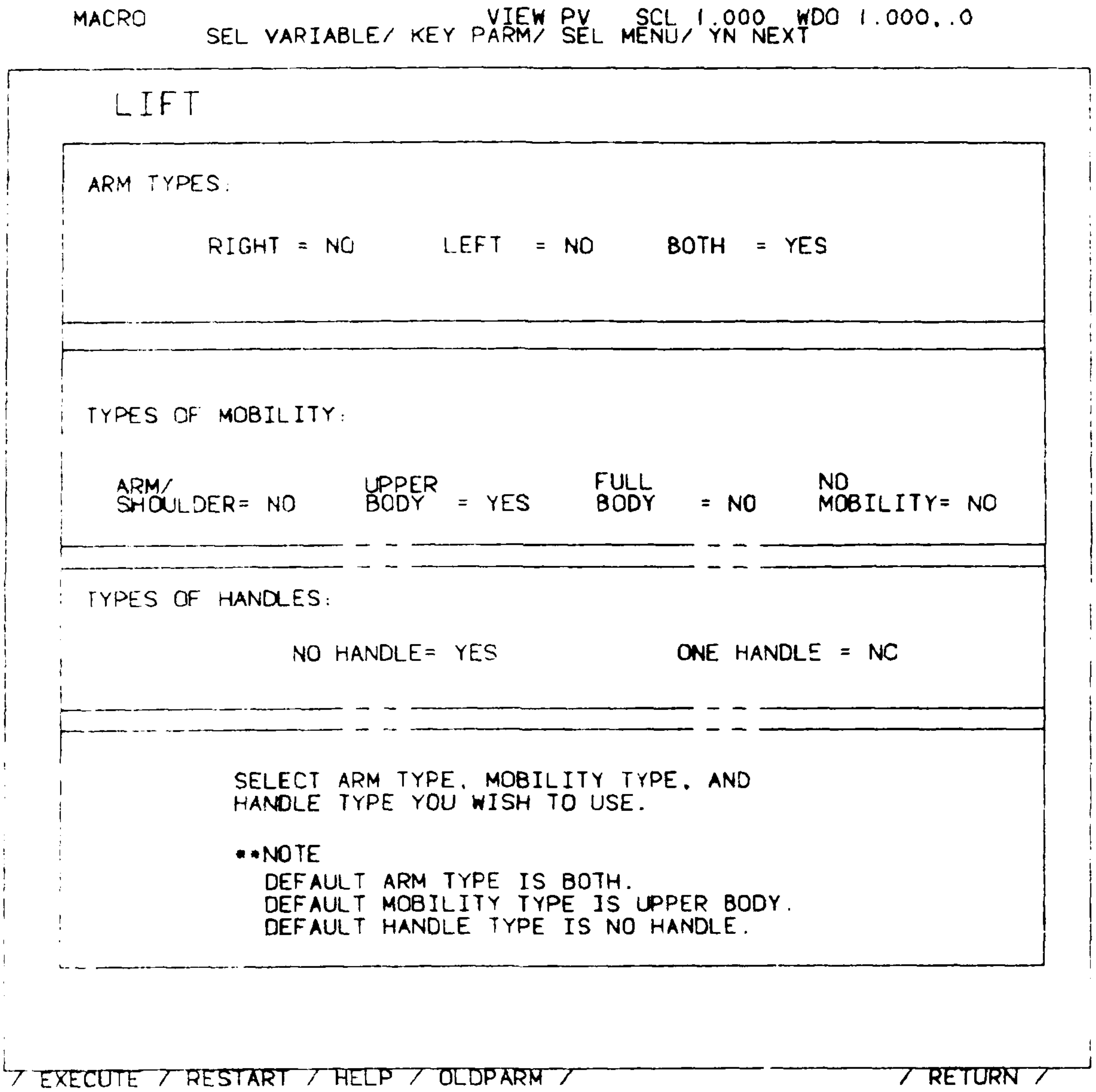


Figure 3.26. Arm, Mobility, and Handle Type Selection Menu for LIFT Task.

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HANDLE TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.26). The most commonly used mobility (UPPER BODY) will have the value YES and will be the default mobility type.

- Accept the default mobility type (**UPPER BODY**)

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility

OR:

- Choose **NO MOBILITY** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement

EXAMPLE: Select **FULL BODY**

RESULT: UPPER BODY, ARM/SHOULDER, and NO MOBILITY all = NO and FULL BODY = YES

PROMPT: SELECT ARM TYPE, MOBILITY TYPE, AND HANDLE TYPE YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select handle type to be used (see Figure 3.26). The most commonly used handle type (NO HANDLE) will have the value YES and will be the default handle type. If the user selects TWO HANDS for ONE HANDLE, the lift task will be abandoned and

the user will be notified, since there is not current data to support a TWO HAND, ONE HANDLE lift combination.

- Accept the default handle type (**NO HANDLE**)

OR:

- Choose **ONE HANDLE**

EXAMPLE: Select **ONE HANDLE**

RESULT: NO HANDLE = NO and ONE HANDLE = YES.

When the user is satisfied with the arm, mobility and handle type selections, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will allow continuance of next step, to specify object dimensions and orientation in the design.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the mode (key in or select) for defining the dimensions (HEIGHT, WIDTH, and DEPTH) of the object to be lifted.

- Choose **/FROM SCREEN/** to allow selection of elements from screen

OR:

- Choose **/KEY IN/** to allow dimensions to be entered at the ANKB

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored and new prompt appears.

If /FROM SCREEN/ is chosen, the user would be prompted to (1) SELECT ELEMENT TO DEFINE OBJECT HEIGHT, (2) SELECT ELEMENT TO DEFINE OBJECT WIDTH, (3) SELECT ELEMENT TO DEFINE OBJECT DEPTH from the screen, and to (4) SELECT OTHER ELEMENTS FOR OBJECT SURFACE. When these other elements have been defined, the user would select /END/ from the bottom menu. These elements define an irregularly shaped object. The user would then be prompted to DEFINE ENDPOINT 1 OF HANDLE and to DEFINE ENDPOINT 2 OF HANDLE. (See Paragraph 9.2.2.3.) If the user selects **/KEY IN/**, as in the example, the following prompt will appear on the screen.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT HEIGHT</u> (prompt appears at top of window)

ACTION: Key in a value representing the height of the object to be lifted **<CR>**

EXAMPLE: Key in **12 <CR>**

RESULT: 12 appears at top left-hand side of window and new prompt appears

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT WIDTH</u> (prompt appears at top of window)

ACTION: Key in a value to represent the width of the object to be lifted <CR>

EXAMPLE: Key in 10.7 <CR>

RESULT: 10.7 appears at top left-hand side of screen and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN OBJECT DEPTH</u> (prompt appears at top of window)

ACTION: Key in a value representing the depth of the object to be lifted <CR>

EXAMPLE: Key in 5.34 <CR>

RESULT: 5.34 appears at top left-hand side of screen and new prompt appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select mode for defining the lift distance. This distance is the vertical distance from the man-model's support plane to the final lift height.

- Choose /KEY IN/ to enter value on ANKB. This value is the final lift height of the object.

<u>OR:</u>

- Choose /SELECT SHELF/ to select an element on the screen which will be the shelf onto which the object will be lifted. This shelf is the final lift height of the object.

EXAMPLE: Select /KEY IN/

RESULT: /KEY IN/ is underscored and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN VERTICAL DISTANCE FOR LIFT</u> (prompt appears at top of window)

ACTION: Key in the vertical distance to lift the object

EXAMPLE: Key in **20 <CR>**

RESULT: 20 appears at top left-hand side of window, and new prompt appears and new bottom menu appear.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN HORIZONTAL DISTANCE FOR LIFT</u> (prompt appears at top of window)

ACTION: Key in the horizontal distance to lift the object. This value represents the distance from the man-model to the front edge of the object.

EXAMPLE: Key in **15 <CR>**

RESULT. 15 appears at top left-hand side of window, and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>INDICATE CENTER OF PLOT</u> (prompt appears at top of window)

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach

RESULT: New prompt and new bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during reach analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to lift the object successfully, the man-model appears superimposed in the drawing as a wire-frame model lifting the object with hands either on the object or on the handles. A strength table is also displayed.

A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.27 diagrams the flow of actions necessary to execute a LIFT analysis.

To continue an analysis, select **/MENU 1/** from bottom menu to return to Materials Handling menu. To continue any other analysis, select **@TSKAN** to return to the Task Analysis menu or select **@CREW** to return to the CREW CHIEF Main Programs menu.

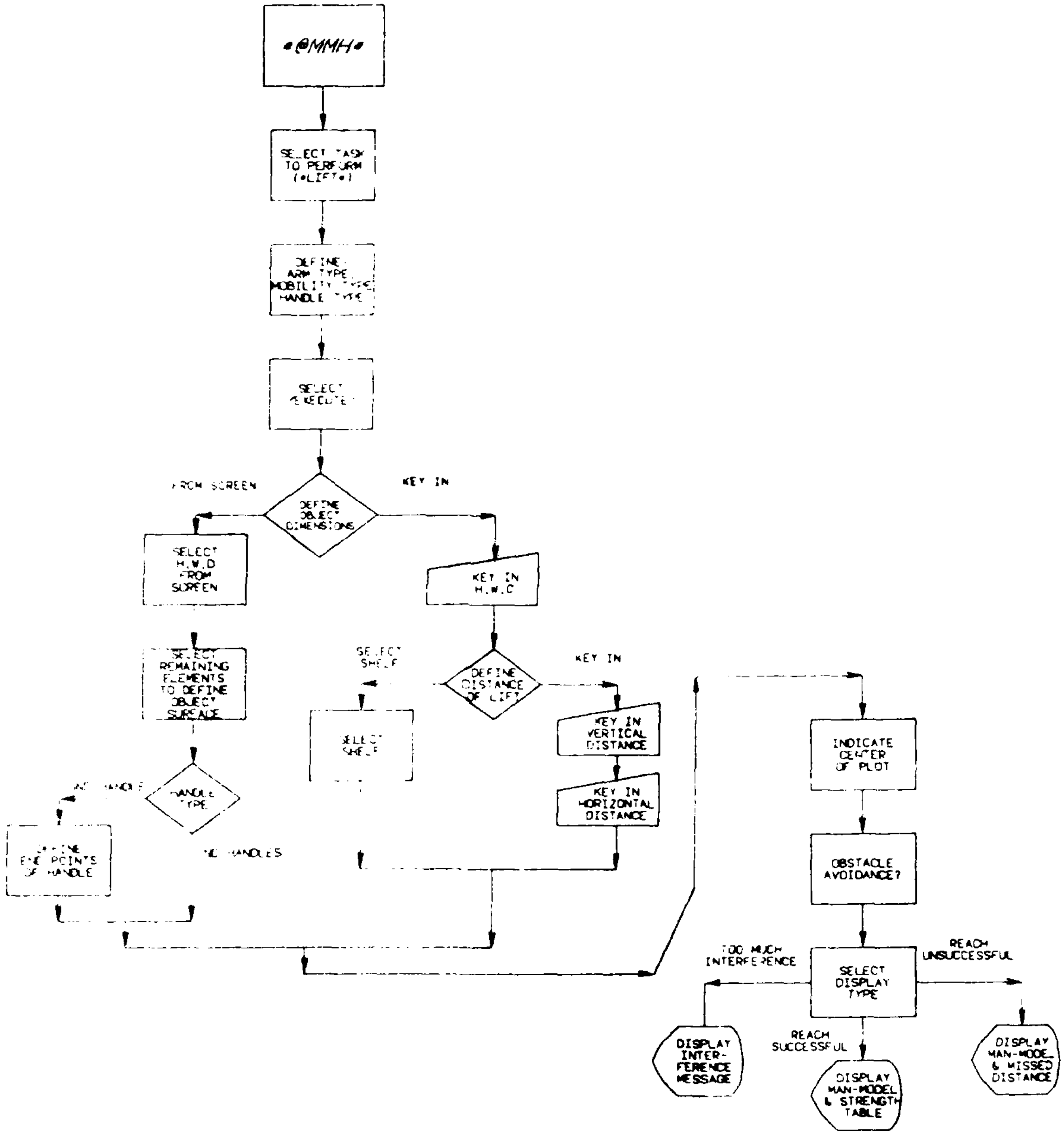


Figure 3.27. Materials Handling Analysis Flow Diagram for LIFT Task.

3.2.4 PUSH

PUSH is the fourth of the eight materials handling tasks, and is selected when the man-model moves an object away from the man-model in a horizontal direction without supporting the weight of the object. For this example, begin by selecting Materials Handling Task menu (**@MMH**).

PROMPT: SELECT NAME OF TASK YOU WISH TO PERFORM (prompt appears in lower third of window)

ACTION: Select the name of the task to be used in the analysis (see Figure 3.22)

EXAMPLE: Select ***PUSH***

RESULT: New prompt appears.

PROMPT: SELECT <u>MOBILITY TYPE</u>, AND NUMBER OF HANDLES YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select mobility type to be used during the reach analysis (Figure 3.28). The most commonly used mobility type (UPPER BODY) will have the value YES and will be the default mobility type.

- Accept the default mobility type **(UPPER BODY)**

<u>OR:</u>

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only

<u>OR:</u>

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility

MACRO VIEW SCL .000 WDO 1.000,.0
SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

PUSH

TYPES OF MOBILITY:

ARM/ SHOULDER= NO   UPPER BODY = YES   FULL BODY = NO   NO MOBILITY= NO

TYPES OF HANDLES:

NO HANDLE = YES   ONE HANDLE= NO   TWO HANDLES= NO

SELECT MOBILITY TYPE AND NUMBER OF HANDLES
YOU WISH TO USE.

**NOTE
DEFAULT MOBILITY TYPE IS UPPER BODY.
DEFAULT HANDLE TYPE IS NO HANDLE.

/ EXECUTE / RESTART / HELP / OLDPARM /   / RETURN /

Figure 3.28. Mobility Type and Number of Handles Selection Menu for PUSH Task.

OR:

- Choose **NO MOBILITY** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movement

EXAMPLE: Select **FULL BODY**

RESULT: UPPER BODY, ARM/SHOULDER, and NO MOBILITY = NO, and FULL BODY = YES

PROMPT: SELECT MOBILITY TYPE, AND NUMBER OF HANDLES YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select handle type to be used (see Figure 3.28). The most commonly used handle type (NO HANDLE) will have the value YES and will be the default handle type. Note that a one-handed push with two handles is not allowed. This combination will automatically default to a one-handed push with one handle.

- Accept the default handle type (**NO HANDLE**)

OR:

- Select **ONE HANDLE**

OR:

- Select **TWO HANDLES**

EXAMPLE: Select **ONE HANDLE**

RESULT: NO HANDLE and TWO HANDLES = NO, and ONE HANDLE = YES.

When the user is satisfied with the mobility and number of handles selections, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will allow continuance of next step, defining object dimensions and orientation in the design.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

If the number of handles chosen was NO HANDLES, the sequence of actions would be to define object dimensions, define a shelf height and define distance away from the object. (See Paragraph 9.2.2.4.) The following sequence of prompts will be used for a **ONE HANDLE** push.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select whether you wish to key in values to define the object dimensions, or if you wish to select elements from the screen to define the object dimensions. If you choose to select elements from the screen, only straight lines and two-point splines are recognized as valid elements.

- Select **/FROM SCREEN/** if the object dimensions are to be defined by selecting screen elements.

OR:

- Select **/KEY IN/** if the object dimensions are to be defined by keying in values.

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored in the bottom menu and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT HEIGHT (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the height of the object.

EXAMPLE: Key in **10.3 <CR>**

RESULT: Value 10.3 appears in the upper left-hand corner of the window and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT WIDTH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the width of the object.

EXAMPLE: Key in **12.0 <CR>**

RESULT: Value 12.0 appears in the upper left-hand corner of the window and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT DEPTH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the depth of the object.

EXAMPLE: Key in **12.0 <CR>**

RESULT: Value 12.0 appears in the upper left-hand corner of the window and a new prompt and bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select whether you wish to key in values to define the shelf height and distance of push, or if you wish to select an element from the screen to define these distances.

- Choose **/SELECT SHELF/** if the push distances are to be defined by selecting an element from the screen.

OR:

- Choose **/KEY IN/** if the push distances are to be defined by keying in values.

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored and a new prompt appears.

PROMPT: SEL MENU / YN REJECT /KEY IN VERTICAL DISTANCE FOR PUSH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the vertical distance for the push.

EXAMPLE: Key in **45.0 <CR>**

RESULT: Value 45.0 appears in the upper left corner of the window and a new prompt appears.

PROMPT: SEL MENU / YN REJECT / KEY IN HORIZONTAL DISTANCE FOR PUSH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the horizontal push distance.

EXAMPLE: Key in **20.5 <CR>**

RESULT: Value 20.5 appears in the upper left corner of the window and a new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN COEFF OF FRICTION OF SHOES/SURFACE</u> (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the coefficient of friction between the man-model's shoes and the surface on which he is standing for this analysis. For description of values, see Figure 7.4 (HELP page).

EXAMPLE: Key in **0.47 <CR>**

RESULT: Value 0.47 appears in upper left-hand corner of window and a new prompt and bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the type of object clearance desired in this analysis. Object clearance is the space between the object and the inner surfaces of the containing area.

- Choose **/CRITICAL/** if the object has a tight clearance

<u>OR:</u>

- Choose **/NON-CRITICAL/** if the object will easily clear the area into which it will be placed

EXAMPLE: Select **/NON-CRITICAL/**

RESULT: /NON-CRITICAL/ is underscored and new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>INDICATE CENTER OF PLOT</u> (prompt appears at top of window)

ACTION: Indicate a point on the window to approximately position the center of the strength table upon completion of a successful reach

RESULT: New prompt and new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during reach analysis; execution time is increased

<u>OR:</u>

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/NO OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire frame man-model

<u>OR:</u>

- Select /FRONT/ to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

<u>OR:</u>

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to push the object successfully, the man-model appears superimposed in the drawing as a wire-frame model pushing the object with his hands either on the object or on the handles. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.29 diagrams the flow of actions necessary to execute a PUSH analysis.

To continue an analysis, select **/MENU 1/** from bottom menu to return to the Materials Handling menu. To continue any other analysis, select **@TSKAN** to return to the Task Analysis menu or select **@CREW** to return to the CREW CHIEF Main Programs menu.

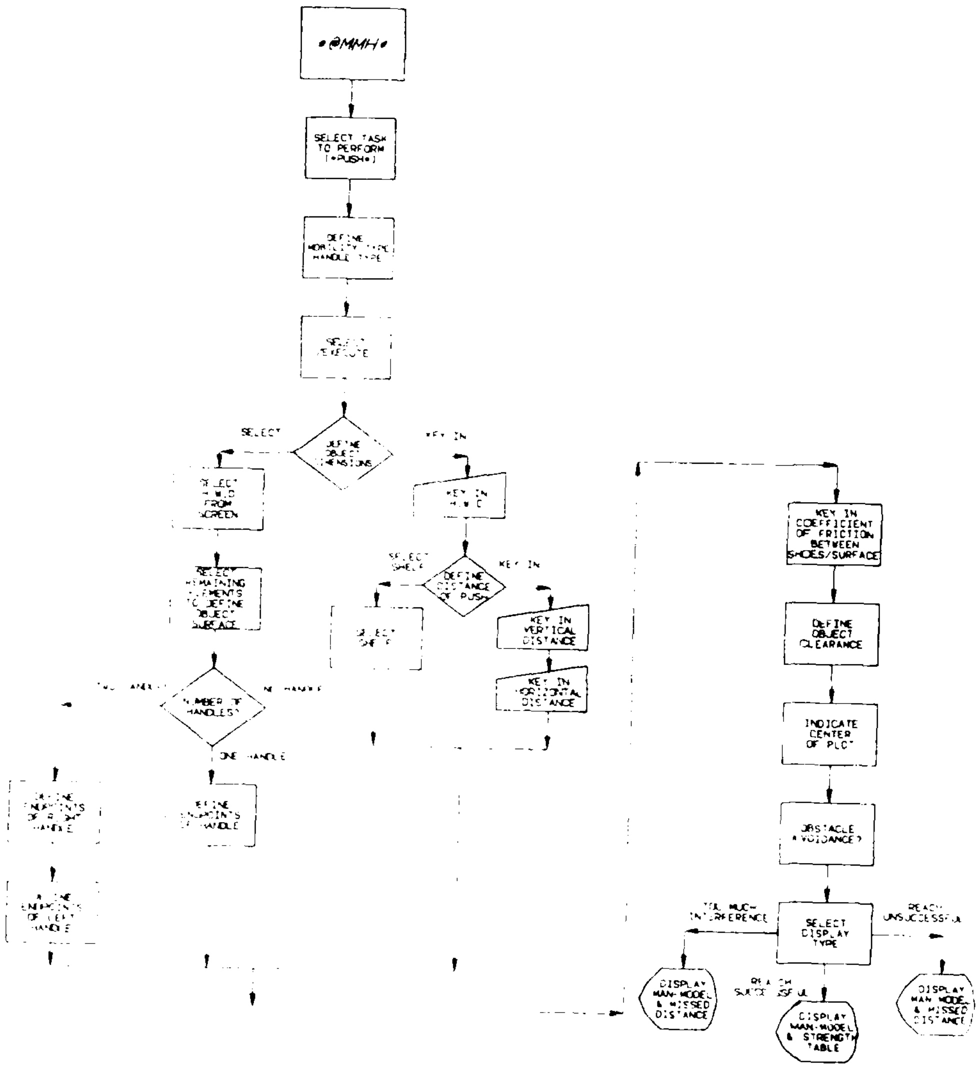


Figure 3 24. Materials Handling Task Analysis Flow Diagram for PUSH Task.

3.2.5 PULL

PULL is the fifth of the eight materials handling tasks and is selected when the man-model moves an object toward the man-model in a horizontal direction without supporting the weight of the object. The PULL task is always performed with BOTH HANDS. For this example, begin by selecting Materials Handling Task menu (**@MMH**).

PROMPT: SELECT NAME OF TASK YOU WISH TO PERFORM (prompt appears in lower third of window)

ACTION: Select the name of the task to be used in the analysis (see Figure 3.22)

EXAMPLE: Select ***PULL***

RESULT: New prompt appears.

PROMPT: SELECT MOBILITY TYPE AND NUMBER OF HANDLES YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select mobility type to be used during the reach analysis (see Figure 3.30). The most commonly used mobility type (UPPER BODY) will have the value YES and will be the default mobility type.

- Accept the default mobility type (**UPPER BODY**)

OR:

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only

OR:

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility

MACRO VIEW PV SCL 1.000 WDO 5.751..0
SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

PULL

TYPES OF MOBILITY:

ARM/ SHOULDER= NO   UPPER BODY = YES   FULL BODY = NO   NO MOBILITY= NO

TYPES OF HANDLES:

ONE HANDLE= YES   TWO HANDLES= NO

SELECT MOBILITY TYPE AND NUMBER OF HANDLES
YOU WISH TO USE.

**NOTE
DEFAULT MOBILITY TYPE IS UPPER BODY.
DEFAULT HANDLE TYPE IS ONE HANDLE.

/ EXECUTE / RESTART / HELP / OLDPARM /   / RETURN /

Figure 3.30. Mobility and Handle Type Selection Menu for PULL Task.

OR:

- Choose **NO MOBILITY** when user wishes to perform strength analysis in displayed posture only, not allowing any body movement

EXAMPLE: Select **FULL BODY**

RESULT: UPPER BODY, ARM/SHOULDER, and NO MOBILITY = NO and FULL BODY = YES

PROMPT: SELECT MOBILITY TYPE AND NUMBER OF HANDLES YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select handle type to be used in the analysis (see Figure 3.30). The most commonly used handle type (ONE HANDLE) will have the value YES and will be the default handle type.

- Accept the default handle type (**ONE HANDLE**)

OR:

- Choose **TWO HANDLES**

EXAMPLE: Accept the default **ONE HANDLE**

RESULT: TWO HANDLES = NO, and ONE HANDLE = YES.

When the user is satisfied with the arm mobility and handle type selections, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from bottom menu. Selecting **/EXECUTE/** will allow user to continue to next

step, definition of object dimensions and orientation in the design.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select whether you wish to key in values to define the object dimensions, or if you wish to select elements from the screen to define the object dimensions. If you choose to select elements from the screen only straight lines and two-point splines are recognized as valid elements.

- Select **/FROM SCREEN/** if the object dimensions are to be defined by selecting screen elements.

OR:

- Select **/KEY IN/** if the object dimensions are to be defined by keying in values.

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored in the bottom menu and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT HEIGHT (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the height of the object.

EXAMPLE: Key in **10.3 <CR>**

RESULT: Value 10.3 appears in the upper left-hand corner of the window and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT WIDTH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the width of the object.

EXAMPLE: Key in **12.0 <CR>**

RESULT: Value 12.0 appears in the upper left-hand corner of the window and a new prompt appears.

PROMPT: SEL MENU/ YN REJECT / KEY IN OBJECT DEPTH (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the depth of the object.

EXAMPLE: Key in **12.0 <CR>**

RESULT: Value 12.0 appears in the upper left-hand corner of the window and a new prompt and bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select whether you wish to key in values to define the shelf height and distance of pull, or if you wish to select an element from the screen to define these distances.

- Choose **/SELECT SHELF/** if the pull distances are to be defined by selecting an element from the screen.

OR:

- Choose **/KEY IN/** if the pull distances are to be defined by keying in values.

EXAMPLE: Select **/KEY IN/**

RESULT: /KEY IN/ is underscored and a new prompt appears.

PROMPT: SEL MENU / YN REJECT /<u>KEY IN VERTICAL DISTANCE FOR PULL</u> (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the vertical distance for the pull.

EXAMPLE: Key in **45.0 <CR>**

RESULT: Value 45.0 appears in the upper left corner of the window and a new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN HORIZONTAL DISTANCE FOR PULL</u> (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the horizontal pull distance.

EXAMPLE: Key in **20.5 <CR>**

RESULT: Value 20.5 appears in the upper left corner of the window and a new prompt appears.

PROMPT: SEL MENU / YN REJECT / <u>KEY IN COEFF OF FRICTION OF SHOES/SURFACE</u> (prompt appears at top of window)

ACTION: Key in a value **<CR>** to define the coefficient of friction between the technician's shoes and the surface on which he is standing for this analysis. (See Figure 7.4 [HELP page] for Coefficient of Friction table.)

EXAMPLE: Key in **0.79 <CR>**

RESULT: Value 0.79 appears in upper left-hand corner of window and a new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the type of object clearance desired in this analysis. Object clearance is the space between the object and the inner surfaces of the containing area.

- Choose **/CRITICAL/** if the object will has a tight clearance

OR:

- Choose **/NON-CRITICAL/** if the object will easily clear the area into which it will be placed

EXAMPLE: Select **/CRITICAL/**

RESULT: /CRITICAL/ is underscored and new prompt appears.

PROMPT: SEL MENU / YN REJECT / INDICATE CENTER OF PLOT (prompt appears at top of window)

ACTION: Indicate a point on the screen to approximately position the center of the strength table upon completion of a successful reach

RESULT: New prompt appears at top of window and new menu appears at bottom of window.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during reach analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/NO OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: If the man-model is able to pull the object successfully, the man-model appears superimposed in the drawing as a wire-frame model pulling the object with his hands either on the object or on the handles. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the

reach is unsuccessful because the distance between the man-model and the object is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.31 diagrams the flow of actions necessary to execute a PULL analysis.

To continue the analysis, select **/MENU 1/** from bottom menu to return to Materials Handling menu. To continue any other analysis, select **@TSKAN** to return to the Task Analysis menu or select **@CREW** to return to the CREW CHIEF Main Programs menu.

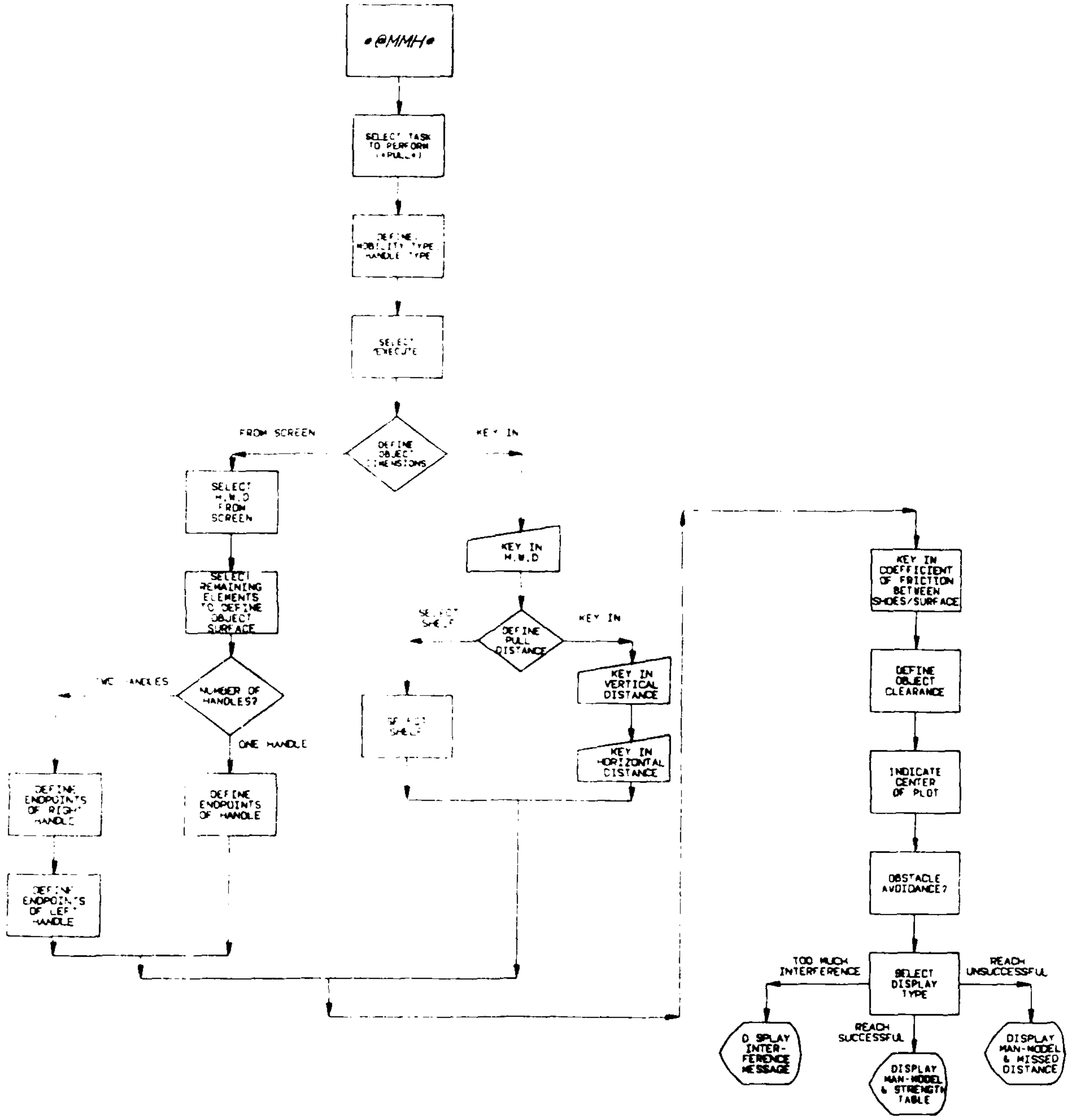


Figure 3.31. Materials Handling Analysis Flow Diagram for PULL Task.

3.2.6 TURN (Not Available at This Time)

TURN is the sixth of the eight materials handling tasks, and is selected when the man-model rotates a handle or object about an axis. For this example, begin by selecting Materials Handling Task menu (**@MMH**).

PROMPT: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM (prompt appears in quarter third of window)

ACTION: Select the name of the task to be used in the analysis (see Figure 3.22).

EXAMPLE: Select ***TURN***

RESULT: "PROGRAM NOT AVAILABLE" message appears in center of window (Figure 3.32)

PROMPT: SELECT /RETURN/ TO EXIT PROGRAM (prompt appears in lower third of window)

ACTION: Select **/RETURN/**

RESULT: Materials Handling Tasks menu appears.

3.2.7 GRASP (Not Available at This Time)

GRASP is the seventh of the eight materials handling tasks and is selected when the man-model takes hold of an object or handle without moving the object or hardle. For this example, begin by selecting Materials Handling Task menu (**@MMH**).

PROMPT: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM (prompt appears in lower quarter of window)

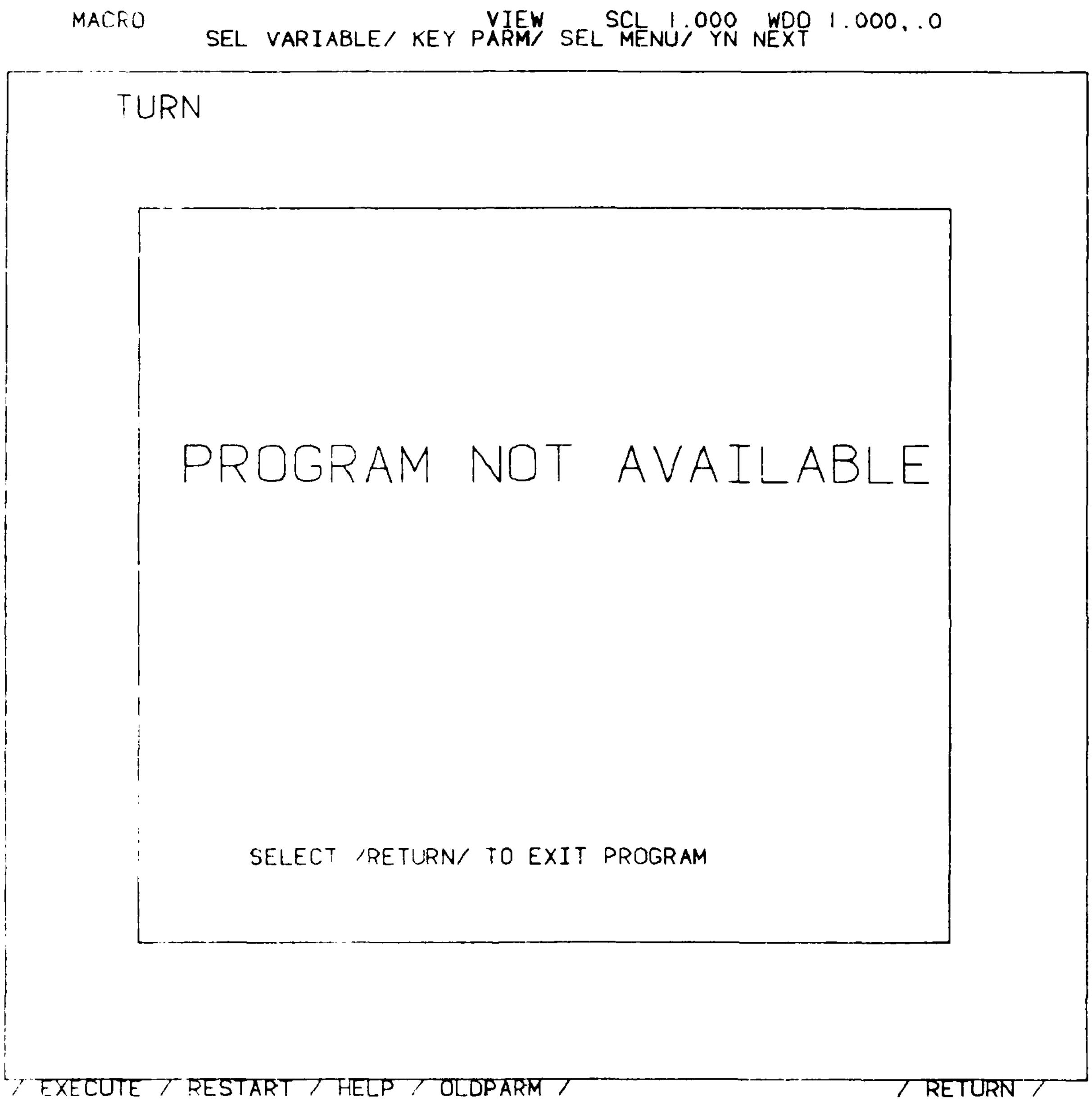


Figure 3.32. "PROGRAM NOT AVAILABLE" Message for Materials Handling Tasks.

ACTION: Select the name of the task used in the analysis (see Figure 3.22).

EXAMPLE: Select ***GRASP***

RESULT: "PROGRAM NOT AVAILABLE" message appears in center of window (Figure 3.32)

PROMPT: SELECT /RETURN/ TO EXIT PROGRAM (prompt appears in lower third of window)

ACTION: Select **/RETURN/**

RESULT: Materials Handling Tasks menu appears.

3.2.8 REACH

REACH is the last of the eight materials handling tasks, and is selected when the man-model moves empty hands to a different location. For this example, begin by selecting Materials Handling Task menu (**@MMH**).

PROMPT: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM (prompt appears in lower quarter of window)

ACTION: Select the name of the task used in the analysis (see Figure 3.22).

EXAMPLE: Select ***REACH***

RESULT: New prompt appears.

PROMPT: SELECT ARM TYPE AND MOBILITY TYPE YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select which arm will be used in the reach analysis (see Figure 3.33). The most commonly

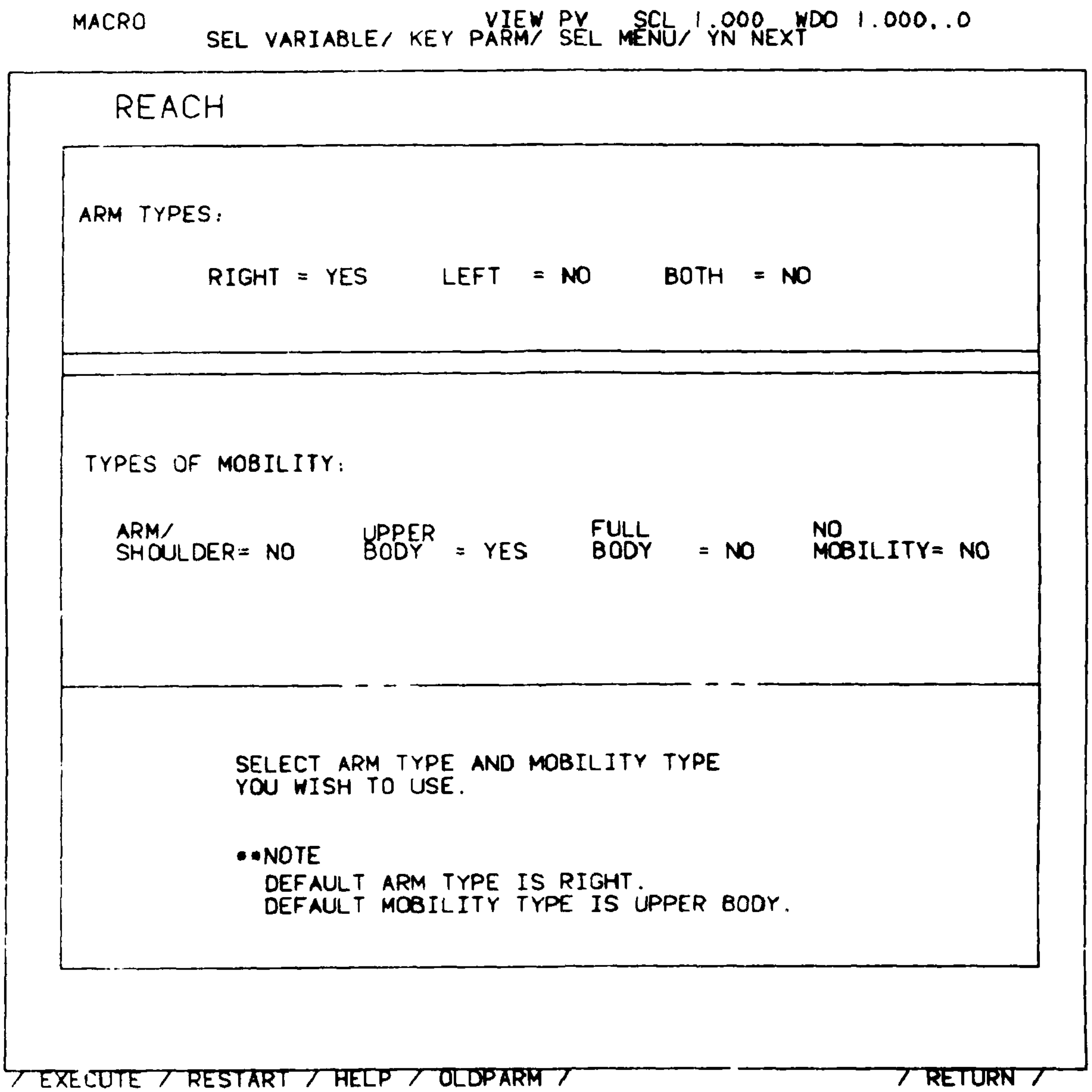


Figure 3.33. Arm and Mobility Type Selection Menu for REACH Task.

used arm (RIGHT) will have the value YES and will be the default arm type.

- Accept the default hand (**RIGHT**)

<u>OR:</u>

- Choose the left hand by selecting **LEFT**

<u>OR:</u>

- Choose both hands by selecting **BOTH**

EXAMPLE: Select **LEFT**

RESULT: RIGHT and BOTH = NO, and LEFT = YES

PROMPT: SELECT ARM TYPE AND <u>MOBILITY TYPE</u> YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select mobility type to use in the reach analysis (Figure 3.33). The most commonly used mobility type (UPPER BODY) will have the value YES and will include the default arm type.

- Accept the default mobility type (**UPPER BODY**)

<u>OR:</u>

- Choose **ARM/SHOULDER** to allow movement of arms and shoulders only

<u>OR:</u>

- Choose **FULL BODY** to allow movement of all body joints; includes upper body mobility

<u>OR:</u>

- Choose **NO MOBILITY** when user wishes to perform strength analysis in the displayed posture only, not allowing any body movements

EXAMPLE: Select **FULL BODY**

RESULT: UPPER BODY, ARM/SHOULDER, and NO MOBILITY = NO, and FULL BODY = YES

When the user is satisfied with the arm and mobility type selections, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT (prompt appears at top of window)

ACTION: Select choice from bottom menu. Selecting **/EXECUTE/** will allow user to continue to next step, defining the reach point(s).

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

PROMPT: SEL MENU / YN REJECT / <u>DEFINE REACH POINT</u> (prompt appears at top of window)

ACTION: Define a 3-D point toward which the man-model will reach

- Select an existing 3-D point from the screen to determine the reach point

<u>OR:</u>

- Key in the X,Y,Z coordinates **<CR>** to determine the reach point

EXAMPLE: Key in **26.74, 170, 39.98 <CR>**

RESULT: The coordinates (26.74, 170, 39.98) appear in the top left-hand corner of the window and a new prompt appears.

If RIGHT (arm) had been selected the prompts would have been the same. If BOTH (arms) had been selected, the prompt for the right hand reach point would have appeared, followed by a prompt for the left hand reach point. (See Paragraph 9.2.2.8.)

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the reach grip type to be used in the analysis

- Choose **/GRIP CTR/**

OR:

- Choose **/FUNCTIONAL/**

OR:

- Choose **/FINGER-TIP/**

EXAMPLE: Select **/FUNCTIONAL/**

RESULT: New prompt and new bottom menu appear

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during reach analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit include obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile view)

EXAMPLE: Select **/WIRE/**

RESULT: New prompt and bottom menu appear.

PROMPT: SEL MENU (appears at top of window)

ACTION: Select one of the items from the bottom menu

EXAMPLE: Select **/EXECUTE/**

RESULT: If the man-model is able to reach the point successfully, the man-model appears superimposed in the drawing as a wire-frame model in the final reach position. A "TASK COMPLETED" message appears in the top left-hand corner of the window. If the reach is unsuccessful because the distance

between the man-model and the reach point is too great, the man-model is displayed attempting to perform the task. The missed distance appears in the top, left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a "TOO MUCH INTERFERENCE. ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top, left-hand portion of the window. A new prompt and a new CADAM-supplied bottom menu appear.

Figure 3.34 diagrams the flow of actions necessary to execute a REACH task.

To continue an analysis, select **/MENU 1/** from bottom menu to return to Materials Handling menu. To continue any other analysis, select **@CREW** to return to the CREW CHIEF Main Programs menu.

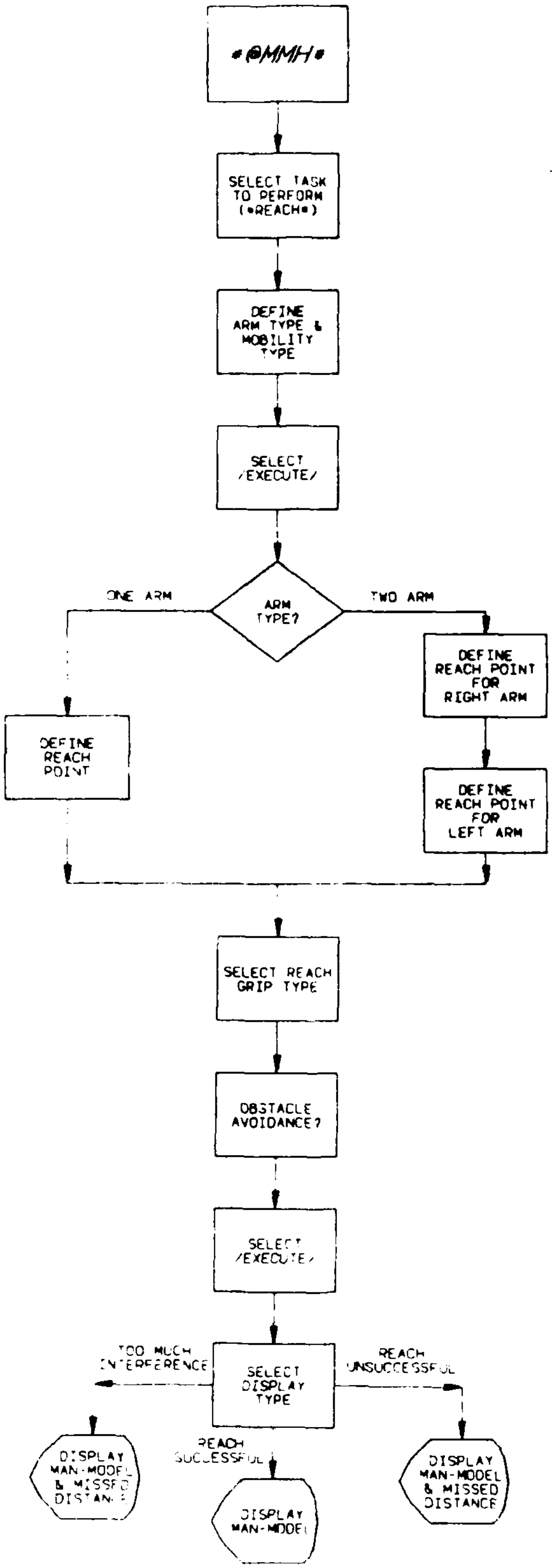


Figure 3.34 **Materials** Handling **Analysis** Flow **Diagram** for **REACH** Task.

3.3 CONNECTOR ANALYSIS FUNCTION (CONNEC)

The Connector Analysis function evaluates the strength capability of the technician to mate an electrical connector at a specified location. This evaluation is given in a table of strength capability related to grip used and size of connector.

To use the Connector Analysis function, choose **@TSKAN** from the CREW CHIEF Main Programs menu (Figure 1.3) which will cause the CREW CHIEF Task Analysis menu to appear on the screen (see Figure 3.1).

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSES FUNCTION YOU WISH TO USE (prompt appears in bottom third of window)

ACTION: Select the abbreviation under the CREW CHIEF Task Analysis function to be performed (see Figure 3.1)

EXAMPLE: Select ***CONNECTOR***

RESULT: Grip Type and Connector Size Selection menu appears (Figure 3.35)

PROMPT: SELECT LABEL NAME WHICH CORRESPONDS TO THE GRIP TYPE AND CONNECTOR SIZE YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the grip type (see Figure 3.35)

- Accept default grip type (**FUNCTIONAL**)

OR:

- Choose alternate grip by selecting **GRIP CENTER**

EXAMPLE: Select **GRIP CENTER**

RESULT: FUNCTIONAL = NO, GRIP CENTER = YES

MACRO DETAIL SCL 1.000 WDO 1.000,.0
SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

CONNECTOR

TYPES OF GRIPS:

FUNCTIONAL = YES GRIP CENTER= NO

SIZES OF CONNECTORS:

0.9 INCHES = YES 1.5 INCHES = NO 2.0 INCHES= NO

SELECT GRIP TYPE AND CONNECTOR SIZE
YOU WISH TO USE.

**NOTE
DEFAULT GRIP TYPE IS FUNCTIONAL GRIP.
DEFAULT CONNECTOR SIZE IS 0.9 INCHES.

/ EXECUTE / RESTART / HELP / OLDPARM / / RETURN /

Figure 3.35. Grip Type and Connector Size Selection Menu.

PROMPT: SELECT LABEL NAME WHICH CORRESPONDS TO THE GRIP TYPE AND <u>CONNECTOR SIZE</u> YOU WISH TO USE (prompt appears in lower third of window)

ACTION: Select the connector size (diameter of lock ring) to be used in the analysis (see Figure 3.35)

- Accept default connector size (**0.9 INCHES**)

<u>OR:</u>

- Choose 1.5-inch connector size by selecting **1.5 INCHES**

<u>OR:</u>

- Choose 2.0-inch connector size by selecting **2.0 INCHES**

EXAMPLE: Select **2.0 INCHES**

RESULT: 0.9 and 1.5 INCHES = NO, ard 2.0 INCHES = YES

PROMPT: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT (prompt appears at top of window)

ACTION: Select choice from bottom menu. Selecting **/EXECUTE/** will allow user to continue to next step, defining the connector in the work area.

EXECUTE: Select **/EXECUTE/**

RESULT: Drawing reappears on the screen and a new prompt and a new menu appear.

When the user is satisfied with the type of grip and the size of the connector, he/she may continue the task analysis by selecting **/EXECUTE/** from the bottom CADAM-supplied menu. (See Section 8 for further explanation of other choices.)

PROMPT: SEL MENU / YN REJECT / DEFINE HEADPOINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define a 3-D point that defines at which point the man-model grips the connector

- Select an existing 3-D point from the screen to determine where the man-model will grip the connector

OR:

- Key in the X,Y,Z coordinates which represent where the man-model will grip the connector **<CR>**

EXAMPLE: Key in **28, 218, 44.75 <CR>**

RESULT: The coordinates (28, 218, 44.75) appear in the top left-hand corner of the window and a new prompt appears

PROMPT: SEL MENU / YN REJECT / DEFINE TAIL POINT OF ATTACH VECTOR (prompt appears at top of window)

ACTION: Define a 3-D point that (along with the head point, or the point at which the man-model grips the connector) defines the direction from which the man-model will reach the connector

- Select an existing 3-D point from the screen to define the axis of the connector and the direction the man-model will reach

OR:

- Key in the X,Y,Z coordinates which will define the axis of the connector and the direction the man-model will reach **<CR>**

EXAMPLE: Key in **28, 221, 44.75 <CR>**

RESULT: The coordinates (28, 221, 44.75) appear in the top left-hand corner of the window and a new prompt appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select which arm will reach to the connector

- Select **/RIGHT/** to use right arm to reach the connector

OR:

- Select **/LEFT/** to use left arm to reach the connector

EXAMPLE: Select **/LEFT/**

RESULT: New bottom menu appears

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used in the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

OR:

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

OR:

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

OR:

- Select **/NONE/** when user wishes to perform srength analysis only, not allowing any body movements

EXAMPLE: Select **/UPR BODY/**

RESULT: /UPR BODY/ is underscored and new prompt appears

PROMPT: SEL MENU / YN REJECT / INDICATE CENTER OF PLOT (prompt appears at top of window)

ACTION: Indicate a point on the window to approximately position the center of the strength-related measurements upon completion of a successful reach.

RESULT: New prompt and new bottom menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the obstacle avoidance choices from the bottom menu to include or to omit obstacle avoidance

- Select **/OBSTACLE AVOIDANCE/** to include obstacle avoidance during reach analysis; execution time is increased

OR:

- Select **/NO OBSTACLE AVOIDANCE/** to omit obstacle avoidance

EXAMPLE: Select **/OBSTACLE AVOIDANCE/**

RESULT: Prompt remains the same, but new bottom menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

<u>OR:</u>

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile View)

EXAMPLE: Select **/WIRE/**

RESULT: New prompt and bottom menu appear.

PROMPT: YN SAME / <u>SEL MENU</u> / (prompt appears at top of window)

ACTION: Select **/EXECUTE/** from bottom of window

RESULT: If the man-model is able to reach the connector, the man-model appears superimposed in the drawing as a wire-frame model holding the connector. A "TASK COMPLETED" message appears in the upper left-hand corner of the window. A table of strength-related measurements is displayed. If the reach is unsuccessful because the distance between the man-model and the connector is too great, the man-model is displayed attempting to perform the reach. The missed distance appears in the top left-hand corner of the window. If the reach is unsuccessful because there are too many obstacles in the man-model's reach path, arrows will indicate points of interference and a

"TOO MUCH INTERFERENCE.ARROWS INDICATE POINTS OF INTERFERENCE" message appears in top left-hand portion of window. A new prompt and a new CADAM-supplied menu appear.

Figure 3.36 diagrams the flow of actions necessary to execute the connector analysis.

To continue an analysis, select **/MENU 1/** from bottom menu and then select **/@CREW/** from Task Analyses menu to continue any other analysis.

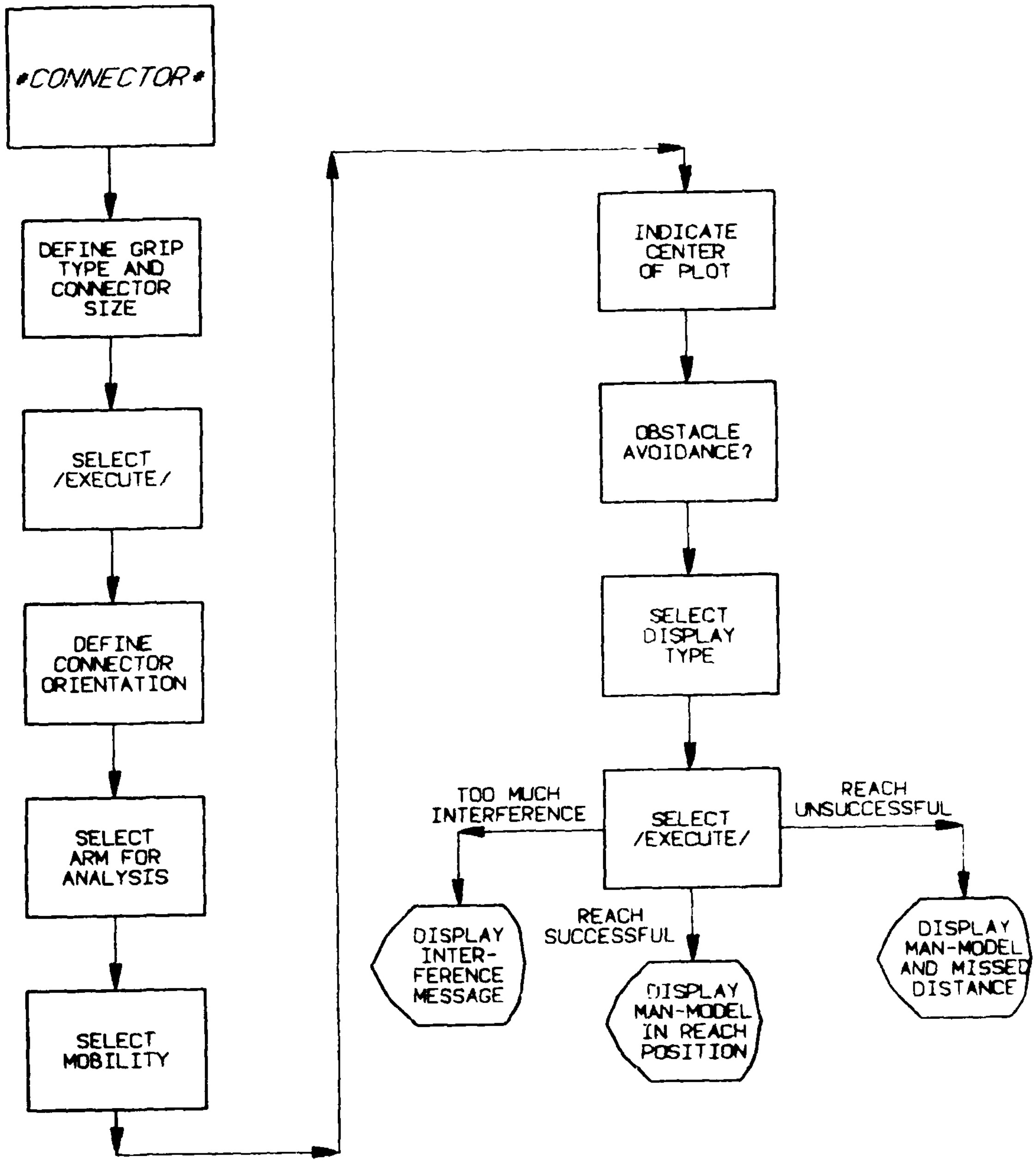


Figure 3.36. Materials Handling Task Analyses Flow Diagram for Connector.

SECTION 4

VISIBILITY ANALYSIS FUNCTION (VISAN)

4.1 INTRODUCTION TO VISIBILITY ANALYSIS

The Visibility Analysis Function program plots a map of visual azimuth and elevation line-of-sight (LOS) angles to work station components in the drawing. The plot is rectilinear, and depicts the visual field as seen by the CREW CHIEF man-model in its current posture, or as seen from a user-chosen, arbitrary viewpoint. The plot is presented on-screen and a hard copy can be obtained using the CADAM Plot Function.

The vision limits will be presented for the baseline condition, which is unrestricted, and for restrictions due to clothing or personal protective equipment such as the Chemical Defense mask. These restrictions will be available as overlays in the program.

4.2 USING THE VISIBILITY ANALYSIS FUNCTION (VISAN)

The first step in using the Visibility Analysis function is to call the CREW CHIEF Main Programs menu (see Figure 1.3) by keying in **@CREW** on the ANKB and following with **<CR>**.

PROMPT: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select the abbreviation for the function to be performed

EXAMPLE: Select ***VISAN***

RESULT: New menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select the viewpoint that depicts the visual field as seen by the man-model or as seen from a user-defined, arbitrary viewpoint.

- Select **/VIEW POINT - CREWCHIEF'S/** to view the visual field as seen by the man-model from his current position and posture

OR:

- Select **/USER DEFINED/** to establish an arbitrary line-of-sight

EXAMPLE: Select **/VIEW POINT - CREWCHIEF'S/**

RESULT: Next prompt appears.

If /USER-DEFINED/ had been selected as the EXAMPLE, then the user would be prompted to DEFINE EYE LOCATION POINT from which the man-model will view the work location and to DEFINE EYE TARGET POINT which defines the man-model's line-of-sight. Next the user would be prompted to indicate CENTER OF PLOT for the visibility plot. (See Paragraph 9.3.) The following prompt appears as a result of selecting **/VIEWPOINT - CREW CHIEF'S/**.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select from the menu whether to include or exclude the man-model. Body parts of the man-model which

are within the visual field of the man-model will or will not be included in the final visibility plot depending on this selection.

- Select **/INCLUDE MAN/** to include the body parts of the man-model which are within the visual field of the man-model in the final visibility plot

OR:

- Select **/EXCLUDE MAN/** to not include the body parts of the man-model which are within the visual field of the man-model in the final visibility plot

EXAMPLE: Select **/INCLUDE MAN/**

RESULT: /INCLUDE MAN/ is underscored and new prompt appears.

PROMPT: SEL MENU/YN REJECT/INDICATE CENTER OF PLOT/ (prompt appears at top of window)

ACTION: Indicate a 2-D point to determine where the center of the visibility plot will appear on the screen

EXAMPLE: Indicate a point on the screen

RESULT: Plot appears on screen at specified center of plot location. New menu appears.

See Figures 4.1-4.3 for examples of vision outlines; the vision outline which appears is dependent upon the clothing type selected during CREW CHIEF Initialization. The bareheaded vision outline, shown by a solid contour and the letters "BH" (Figure 4.1, i.e., the result of choosing fatigues or fatigues with jacket), is plotted regardless of the clothing type selected.

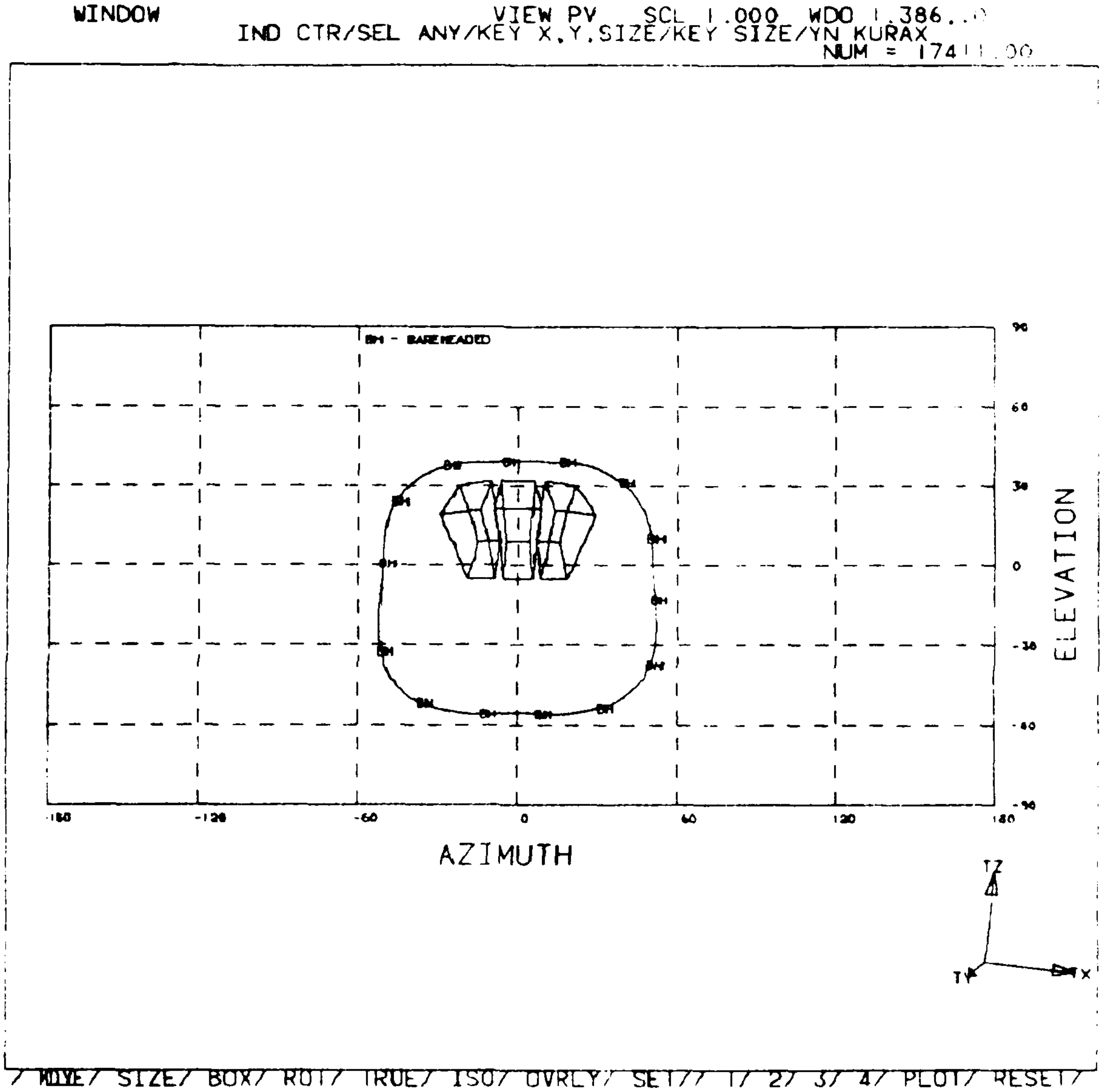


Figure 4.1. An Example of the Vision Outline Which is Shown When the Fatigues or the Fatigues with Jacket Clothing Type is Selected. "BH" Represents the Bareheaded Visual Field.

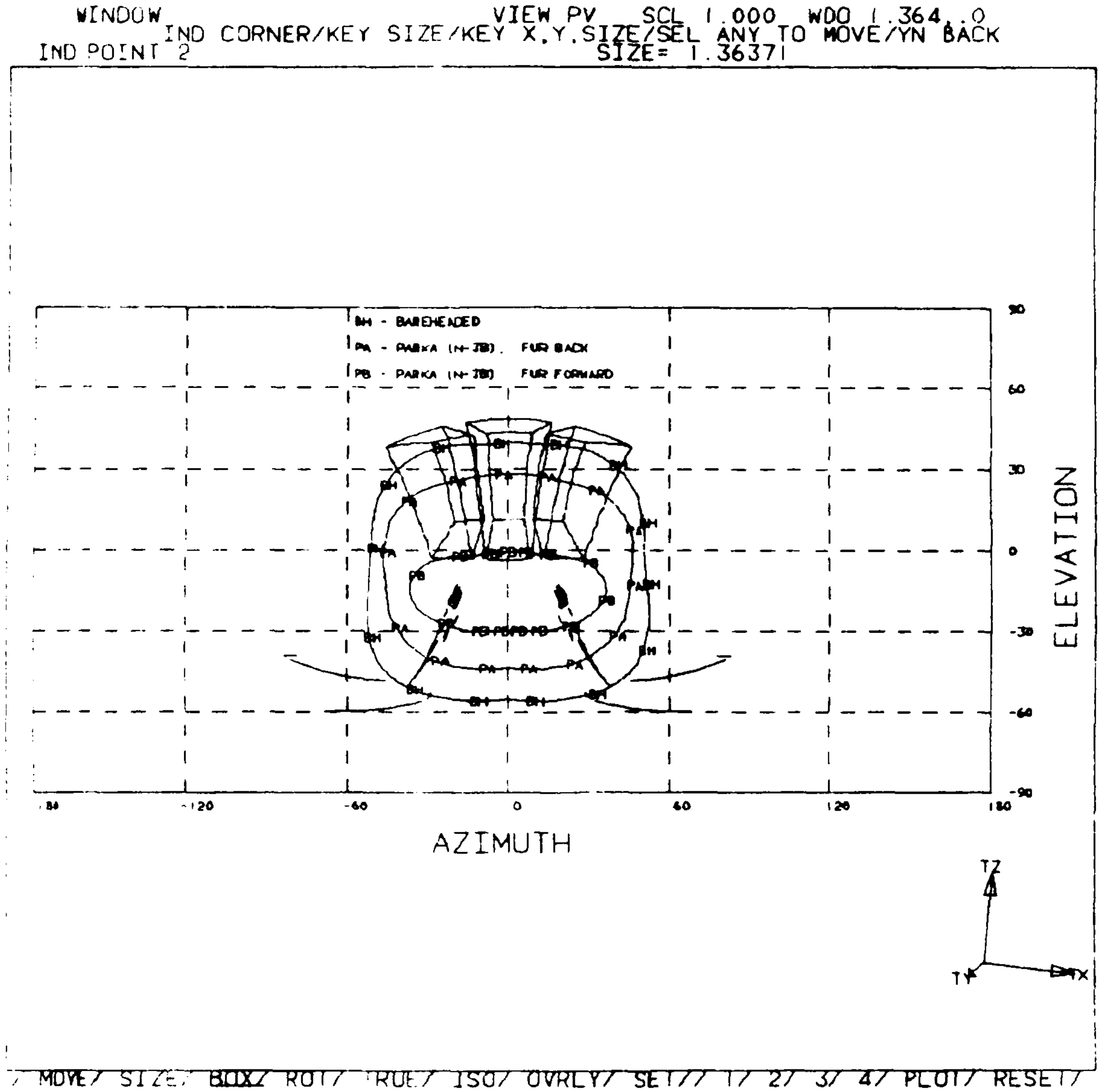


Figure 4.2. An Example of the Vision Outline Which is Shown When the Arctic Clothing Type is Selected. "PA" Represents the Visual Field with Fur-Trimmed Edge of the Parka Hood Pulled Away from the Face; "PB" Indicates the Visual Field with Fur Edge of Hood Pushed Toward the Face. "BH" Shows the Bareheaded Visual Field.

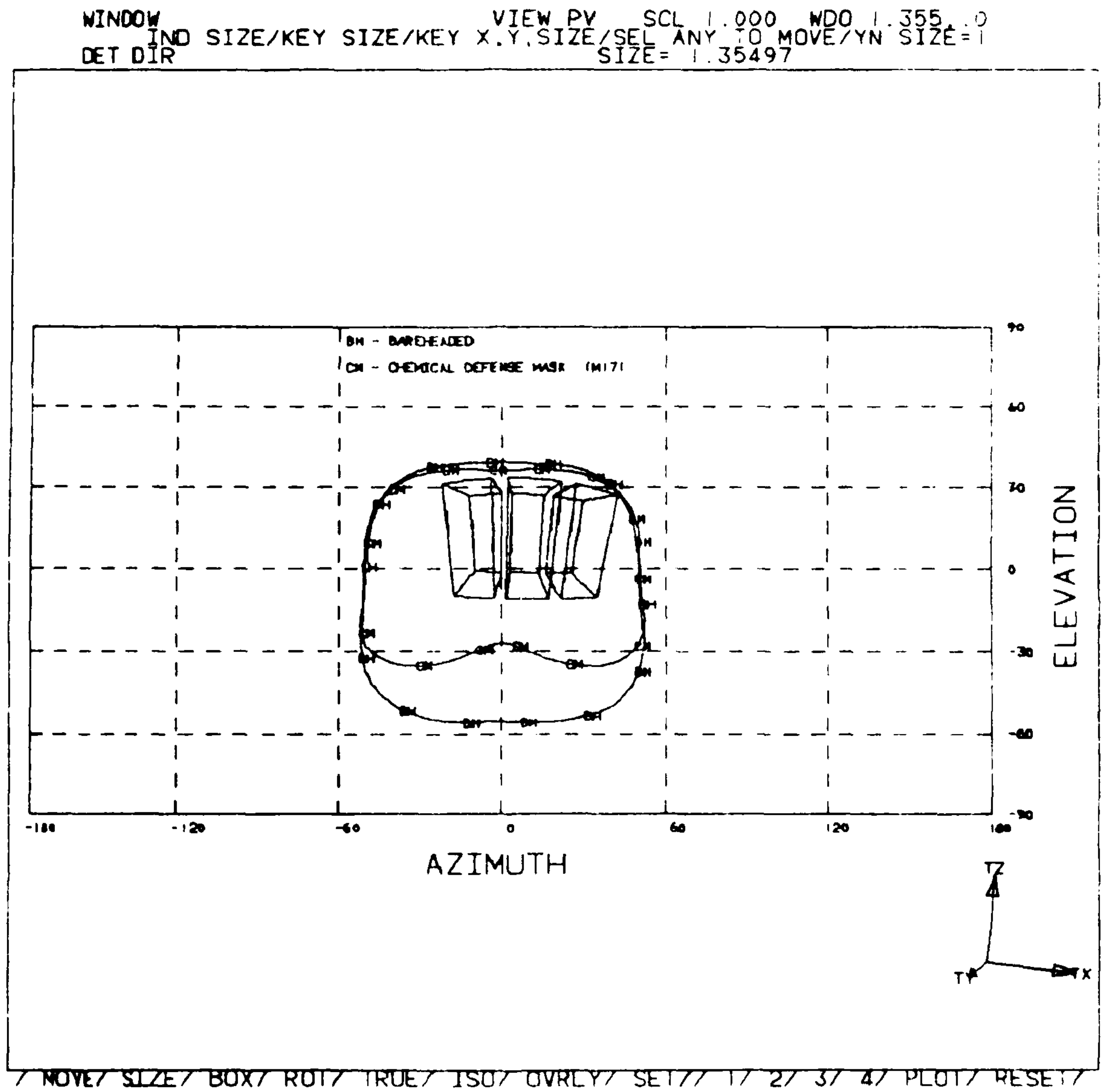


Figure 4.3. An Example of the Vision Outline Which is Shown When the Chemical Defense Clothing Type is Selected. "CM" Represents the Visual Field with Chemical Defense Mask. "BH" Shows the Bareheaded Visual Field.

When the arctic ensemble is selected, two dashed contours appear (see Figure 4.2). The outline labeled "PA" represents the visual field of the man-model wearing the parka hood with the fur-trimmed edge pulled away from the face. The outline labeled "PB" denotes the visual field with the parka hood fur edge pushed toward the face (in the snorkel opening position). The bareheaded vision outline, as described previously, is also displayed.

If the chemical defense ensemble is selected, the dashed contour labeled "CM" appears (Figure 4.3). Again, the bareheaded vision outline described previously is also displayed.

After the plot appears on the screen, it may be necessary to increase the size of the plot to be viewed correctly. This can be accomplished by depressing CADAM's window function key and using the appropriate menu items to view the plot. After the user has viewed the plot, he/she should depress the Macro Geometry function key to continue any analysis.

Figure 4.4 diagrams the flow of action necessary to execute a visibility analysis.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen to return to CREW CHIEF Main Programs menu.

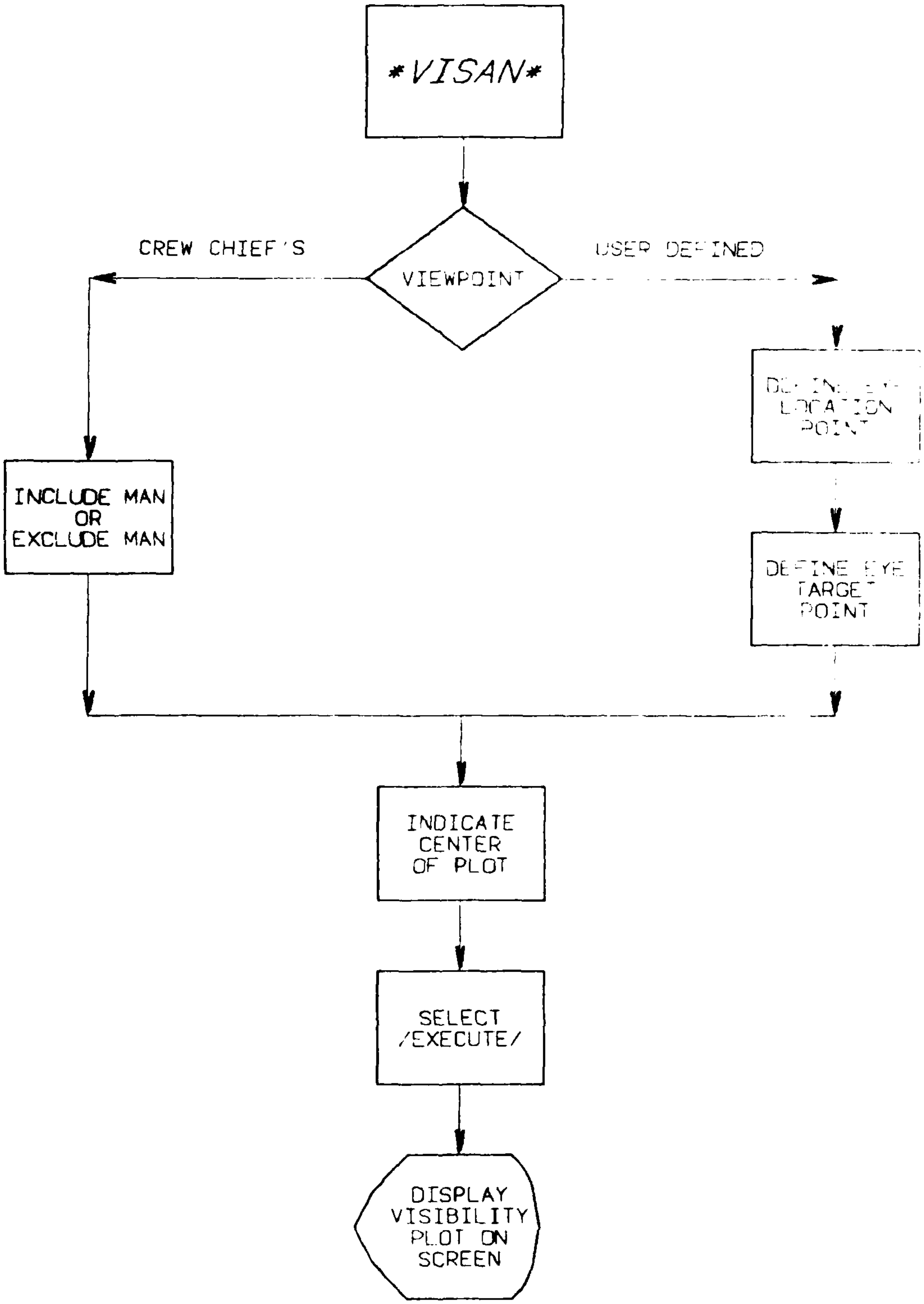


Figure 4.4. Visibility Analysis Flow Diagram.

SECTION 5

ACCESSIBILITY ANALYSES FUNCTION (@ACCES)

The Accessibility Analyses function is provided to perform analyses concerning interference between elements of the CREW CHIEF technician model and elements of the drawing depicting the location of work. The function is broken into two areas: Interference Analysis (INTFER), which checks interference between the man-model and drawing elements in a static condition, and Work Envelope Analysis (WRKENV), which is a quasi-dynamic interference check. WRKENV presents a graphic display of the volume of space required to operate a tool or the movement of an object, such as a component to be removed or installed, in the work area.

Interference can be observed on the screen by viewing both the drawing and the man-model from different perspectives. In some cases this is the easiest and quickest way for the user to check for interference.

The Accessibility Analysis function is initiated as follows. First call the CREW CHIEF Main Programs menu (see Figure 1.3) by keying in **@CREW <CR>**.

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in bottom third of window)

ACTION: Select the abbreviation for the analysis to be performed

EXAMPLE: Select ***@ACCES***

RESULT: The CREW CHIEF Accessibilicy Analyses menu appears (Figure 5.1)

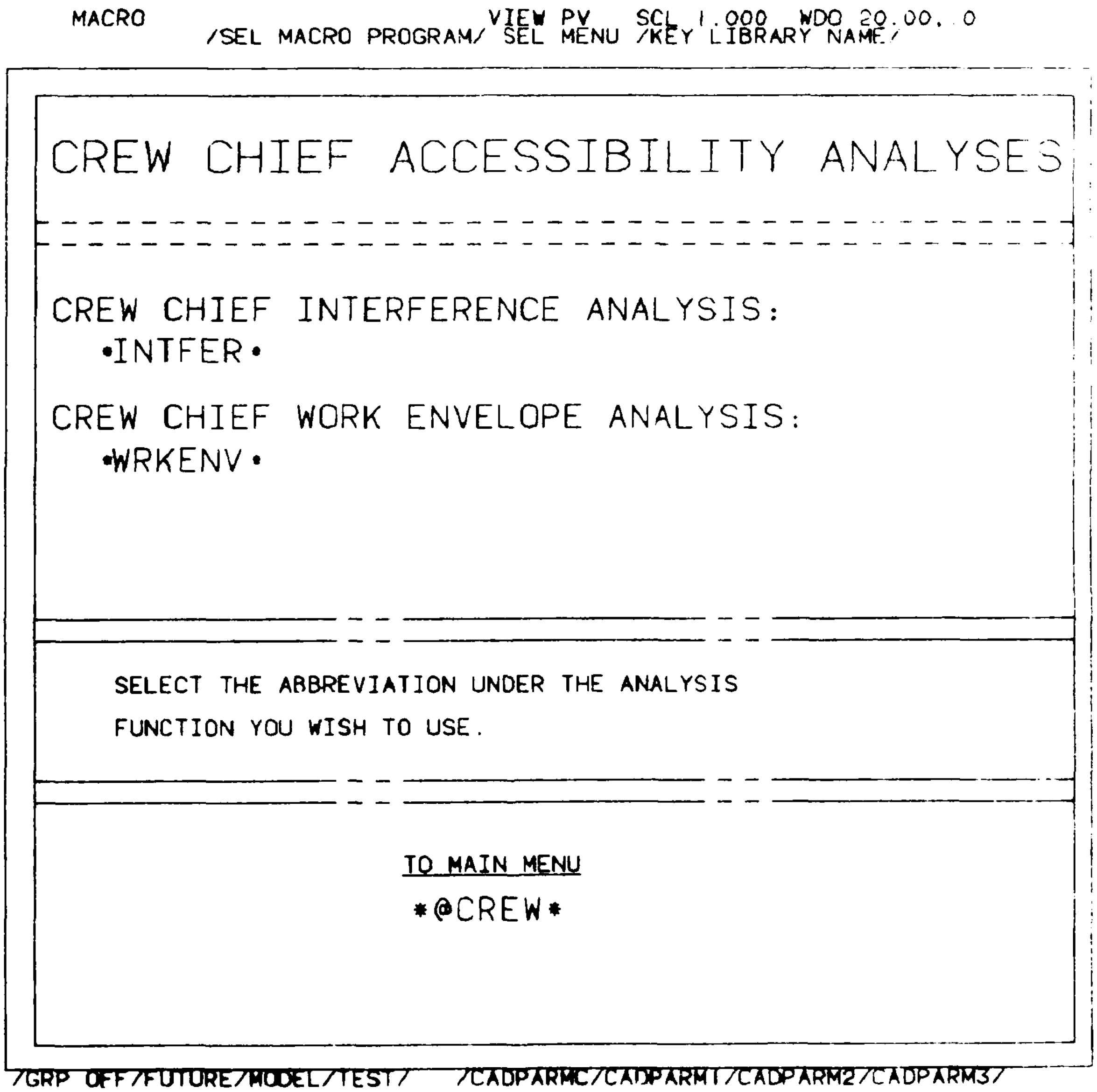


Figure 5.1. CREW CHIEF Accessibility Analyses Menu.

Choose the desired Accessibility Analysis function by selecting **INTFER** or **WRKENV**.

5.1 CREW CHIEF INTERFERENCE ANALYSIS FUNCTION (INTFER)

5.1.1 Introduction to Interference Analysis

Interference checking of a complex drawing is generally a time-consuming process. For this reason, the user should employ the "NO-SHOW" capabilities of CADAM to temporarily remove drawing elements that are obviously out of the interference range of the man-model elements.

The CREW CHIEF program also allows the user to check interference for the whole body or portions of the body (with or without a tool). The user can check interference for the shoulders, arms and hand, or the upper torso which includes all body elements from the waist up, or the whole body. A tool will be included if a tool was used in the previous analysis. By using the "NO-SHOW" capabilities of CADAM, the program only has to check the "shown" drawing elements and the designated body/tool elements for interference, a task which significantly reduces computer processing time.

Interference checking is performed using the current posture configuration and position of the man-model. Thus, before performing any Interference Analysis, the man-model must be generated and placed in the desired posture and position using the Initialization, Reposition, and/or Task Analysis functions. The program searches for interference between the man-model

and drawing elements, displays CADAM 3-D arrows indicating points of interference, and indicates at the top of the screen whether or not interference is found.

5.1.2 Using the Interference Analysis Function

To use the Interference Analysis function, select **@ACCES** from the CREW CHIEF Main Programs menu (Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (Figure 5.1).

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select the abbreviation for the function to be performed

EXAMPLE: Select ***INTFER***

RESULT: New menu appears

PROMPT: SELECT THE LEVEL OF INTERFERENCE CHECKING YOU WISH TO USE (prompt appears in middle third of window)

ACTION: Select the level of interference checking to be used (Figure 5.2). The level of interference checking chosen determines which body parts will be included during interference checking. The more body parts contained in the level, the more execution time is required to evaluate the interference. Also execution time of the interference analysis will decrease if elements that definitely do not interfere with the man-model are "NO-SHOWED" before the analysis.

MACRO VIEW PV SCL 1.000 WDO 20.00,.0

SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

INTFER

LEVELS OF INTERFERENCE CHECKING:

ARMS ONLY = YES	ARMS AND UPPER TORSO = NO	FULL BODY = NO

SELECT THE LEVEL OF INTERFERENCE CHECKING
YOU WISH TO USE.

EXECUTION TIME OF INTERFERENCE ANAYLSIS WILL
DECREASE IF PARTS OF CADAM DRAWING ARE "NO-SHOWED".

/ EXECUTE / RESTART / HELP / OLDPARM / / RETURN /

Figure 5.2. Level of Interference Checking Menu.

- Select **ARMS ONLY** to include only the arms, hands, and tool (if applicable) for possible interference between the man-model and the elements in the drawing

OR:

- Select **ARMS AND UPPER TORSO** to include all body elements from the waist up for possible interference between the man-model and the elements in the drawing

OR:

- Select **FULL BODY** to include the whole body for possible interference between the man-model and the elements in the drawing

EXAMPLE: Select **ARMS AND UPPER TORSO**

RESULT: ARMS ONLY = NO, ARMS AND UPPER TORSO = YES, and FULL BODY = NO.

When the user is satisfied with the level of interference checking, he/she may continue the Interference Analysis by selecting **/EXECUTE/** from the bottom, CADAM-supplied menu (see Section 8 for further explanation of other choices).

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will allow the user to continue the Interference Analysis

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on screen and a new prompt and a new menu appear.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or RESPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

OR:

- Select **/FRONT/** to display front half of wire-frame man-model

OR:

- Select **/PROFILE/** to display profile view of man-model

NOTE: Do not select **/REPOSITION/** (not available at this time)

EXAMPLE: Select **/WIRE/**

RESULT: The man-model will appear in the drawing as a wire-frame model. If interference was found, 3-D arrows indicate the points where the man-model (depending on level of interference chosen) intersects with elements in the drawing. The message "ARROWS BELOW INDICATE POINT OF INTERFERENCE" is displayed. If no interference is found, then the message "NO INTERFERENCE FOUND IN UPPER BODY LEVEL" is displayed (this message will change depending on level of interference selected).

Figure 5.3 diagrams the flow of actions necessary to execute an Interference Analysis.

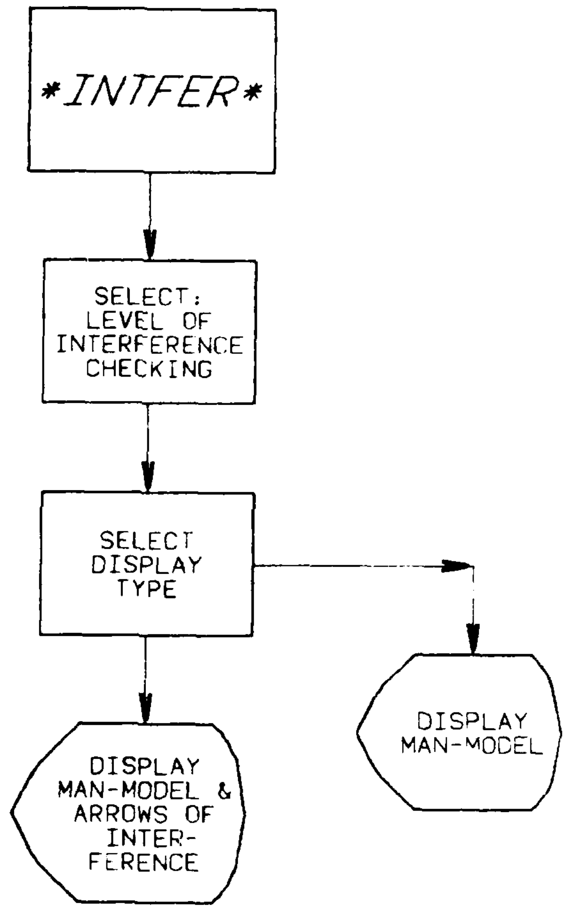


Figure 5.3. Interference Analysis Flow Diagram.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu.

5.2 WORK ENVELOPE ANALYSIS FUNCTION (WRKENV)

The interface for this function is not fully developed. If the user selects WRKENV, the program will display a "PROGRAM NOT AVAILABLE" message (see Figure 3.32). Prior to using the Work Envelope Analysis function, the user will be required to perform a Task Analysis to establish the parameters for the volume required for using a tool or handling an object.

5.2.1 Introduction to Work Envelope Analysis

The work envelope analysis currently evaluates the volume of space that is available for the operation of a tool task. The function requires that a successful obstacle avoidance tool reach was previously performed. The work envelope is defined relative to the location of the tool as defined in the Tool Analysis function (see Paragraph 3.1), and can be greatly affected by the handle direction chosen.

The Work Envelope evaluates three types of envelopes. In the first type of envelope, a full sweep of the tool handle can be viewed. This evaluation does not take into account obstructions in the work place or the ability of the man-model to reach the tool handle for the full sweep. In the second type of envelope, a tool envelope can be evaluated. This considers obstructions that will affect the sweep of the tool, but reach is not evaluated. The third type of envelope is the work envelope. This evaluates the ability of the man-model to reach the handle of the tool during the sweep of the tool, and also takes into

account obstacles in the work place. The work envelope can be very time-consuming, depending upon the reach interval increment given and the number of obstacles near the tool.

Several tools available in the Tool Analysis function have undefined envelopes: hammer, scraper, and safety wire pliers. Also several tools do not have an envelope: drill, chisel, sander, combination pliers, needlenose pliers, wire cutters, nutdriver, regular screwdrivers, and when using long end allen wrenches.

5.2.2 Using the Work Envelope Analysis Function

To use the Work Envelope Analysis function, select **@ACCES** from the CREW CHIEF Main Programs menu (Figure 1.3) which will display the CREW CHIEF Accessibility Analysis menu (Figure 5.1).

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select the abbreviation for the function to be performed

EXAMPLE: Select ***WRKENV***

RESULT: New menu appears.

PROMPT: SELECT THE TYPE OF ENVELOPE, AND IF NECESSARY, KEY IN THE REACH INCREMENT YOU WISH TO USE

ACTION: Select one of the envelope types to be evaluated (Figure 5.4). The envelope type chosen will affect the execution time of the analysis. The sweep volume will require the least amount of time

MACRO VIEW PV SCL 1.000 WDO .29. 0
SEL VARIABLE/ KEY PARM/ SEL MENU/ YN NEXT

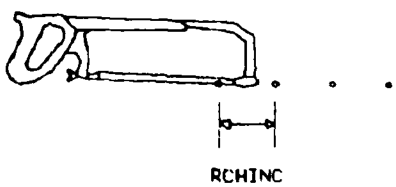
WRKENV

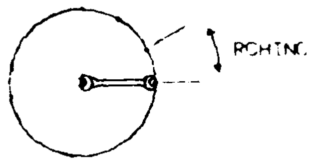
TYPES OF ENVELOPES:

SWEPT	TOOL	WORK
VOLUME= NO	ENVELOPE= YES	ENVELOPE = NO
(FULL SWEEP OF HANDLE)	(OBSTRUCTED SWEEP OF HANDLE)	(REACH INCLUDED)

REACH INCREMENT: REQUIRED ONLY IF *WORK ENVELOPE*
(RCHINC) IS SELECTED

RCHINC= 2.00 UNITS





SELECT THE TYPE OF ENVELOPE, AND IF NECESSARY,
KEY IN THE REACH INCREMENT YOU WISH TO USE

**NOTE
DEFAULT ENVELOPE TYPE IS TOOL ENVELOPE.
DEFAULT REACH INCREMENT IS 2.0 UNITS.

/ EXECUTE / RESTART / HELP / OLDPARM / / RETURN /

Figure 5.4. Types of Work Envelopes Menu.

since reach and obstacles are not considered. The work envelope will require the greatest amount of time, because it considers the number of obstacles near the tool and the ability to reach the tool handle during the sweep of the tool.

- Select **SWEPT VOLUME** to evaluate the sweep of the tool handle (ability to reach the tool handle and obstacles in the reach path are not considered)

<u>OR:</u>

- Accept the default type, **TOOL ENVELOPE**, to evaluate the sweep of the tool handle considering obstacles in the sweep path (tool handle position will effect this envelope (see Figure 5.5))

<u>OR:</u>

- Select **WORK ENVELOPE** to evaluate the sweep of the tool handle considering the ability of the man-model to reach the handle and any obstacles that are in the sweep path (tool handle position will effect this envelope (see Figure 5.5))

EXAMPLE: Select **WORK ENVELOPE**

RESULT: SWEPT VOLUME = NO, TOOL ENVELOPE = NO, and WORK ENVELOPE = YES

If the example chosen had been either SWEPT VOLUME or TOOL ENVELOPE, the user would select /EXECUTE/ from the bottom CADAM-supplied menu (see Section 8 for further explanation of choices). As a result of selecting **WORK ENVELOPE**, the following prompt must be considered.

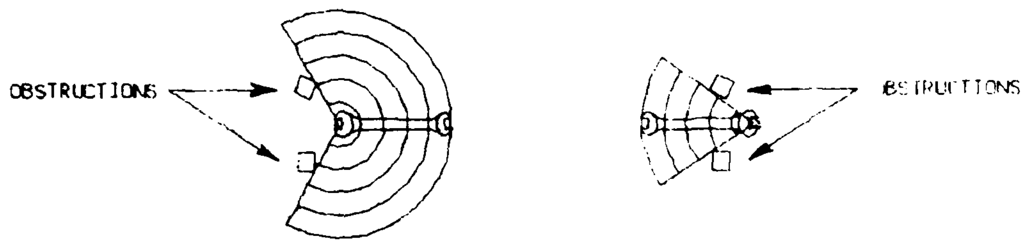


Figure 5.5. The Work Envelope, Defined Relative to the Location of the Tool, is Greatly Affected by the Chosen Handle Direction. To Change Handle Direction, User Must Rerun the Tool Analysis.

PROMPT: SELECT THE TYPE OF ENVELOPE, AND IF NECESSARY, KEY IN THE REACH INCREMENT YOU WISH TO USE

ACTION: Determine the reach increment to be used. The reach increment is the increment used for the sweep of the tool handle. The ability of the man-model to reach the handle at each of these increments (along with obstacles) is evaluated. NOTE: The reach increment must be equal to or greater than 0.5 inches.

- Accept the default value of **2.00 UNITS**

OR:

- Key in the reach increment value (RCHINC) **<CR>**

EXAMPLE: Key in **1.5 <CR>**

RESULT: 1.5 appears in center of screen.

When the user is satisfied with the envelope type and the reach increment, he/she may continue the Work Envelope Analysis by selecting **/EXECUTE/** from the bottom CADAM-supplied menu (see Section 8 for further explanation of choices).

PROMPT: SEL VARIABLE / KEY PARM / SEL MENU / YN NEXT (prompt appears at top of window)

ACTION: Select choice from menu at bottom of window. Selecting **/EXECUTE/** will allow the user to continue the Work Envelope Analysis.

EXAMPLE: Select **/EXECUTE/**

RESULT: Drawing reappears on screen and a new prompt and a new menu appear.

If either SWEPT VOLUME or TOOL ENVELOPE were selected as the example, the user would next be prompted to select a display type. As a result of selecting **WORK ENVELOPE**, the following menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the mobility types to be used in the reach analysis from the bottom menu

- Select **/ARM-SHLD/** to allow movement of arms and shoulders only

<u>OR:</u>

- Select **/UPR BODY/** to allow movement from waist up; includes arm/shoulder mobility

<u>OR:</u>

- Select **/LWR BODY/** to allow movement of all body joints; includes upper body mobility

EXAMPLE: Select **/UPR BODY/**

RESULT: A new menu appears.

PROMPT: SEL MENU (prompt appears at top of window)

ACTION: Select one of the display types from the bottom menu (see Table 2.1 for definitions of WIRE, FRONT, PROFILE, or REPOSITION)

- Select **/WIRE/** to display a 3-D wire-frame man-model

<u>OR:</u>

- Select **/FRONT/** to display front half of wire-frame man-model

<u>OR:</u>

- Select **/PROFILE/** to display profile view of man-model

OR:

- Select **/REPOSITION/** to display reposition view of man-model when manual repositioning is desired (Currently defaults to Profile View.)

EXAMPLE: Select **/WIRE/**

RESULT: If the envelope type chosen was WORK ENVELOPE, the man-model appears in the drawing with the tool(s) attached as it was in the previous tool analysis. The sweep demarcation lines, which are dependent upon the ability of the man-model to reach the tool(s) during the handle sweep and the obstacles that would possibly prevent a full sweep of the tool, appear. If the envelope type chosen was either SWEPT VOLUME or TOOL ENVELOPE, only the sweep demarcation lines and the tool(s) appear. For SWEPT VOLUMF, these lines indicate a full sweep of the tool handle without any restrictions. For TOOL ENVELOPE, these lines indicate the handle sweep possible if obstacles are considered (see Figure 7.8).

NOTE: If the display of the envelope is from a rotational type tool (e.g., wrenches), then the lines displayed represent the clockwise and counterclockwise angle (in degrees) with relation to the initial tool position. The direction of clockwise angles is in the same direction of a

right-threaded screw or bolt. Likewise, counterclockwise is in the oposite direction. If the enveloped displayed represents a translation type tool (hacksaw, file, etc.), then the lines represent the distance that the tool can travel in a forward direction (in user-defined units).

Figure 5.6 diagrams the flow of actions necessary to execute a Work Envelope Analysis.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen and then will select **@CREW** to return to CREW CHIEF Main Programs menu.

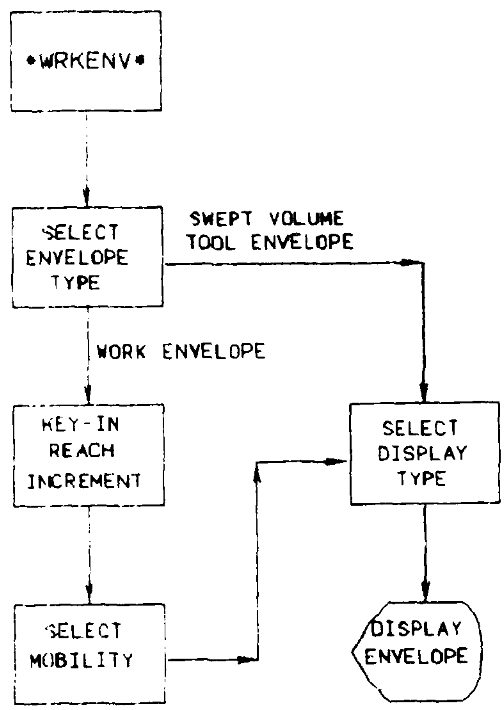


Figure 5.6. Work Envelope Analysis Flow Diagram.

SECTION 6

DISPLAY CURRENT CREW CHIEF DATA FUNCTION (CONFIG)

6.1 INTRODUCTION TO DISPLAY CURRENT CREW CHIEF DATA FUNCTION

The Display Current CREW CHIEF Data function displays the selected or default values of the parameters used in the execution of the CREW CHIEF functions. Figure 6.1 shows the format.

6.2 USING THE DISPLAY CURRENT CREW CHIEF FUNCTION

To use the Display Current CREW CHIEF Data function, select **CONFIG** from the CREW CHIEF Main Programs menu (see Figure 1.3).

PROMPT: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE (prompt appears in lower quarter of window)

ACTION: Select the abbreviation for the function to be performed

EXAMPLE: Select ***CONFIG***

RESULT: New prompt appears.

PROMPT: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a 2-D point to determine where the center of the current CREW CHIEF data sheet will appear on the screen

RESULT: The current CREW CHIEF data sheet appears on the screen.

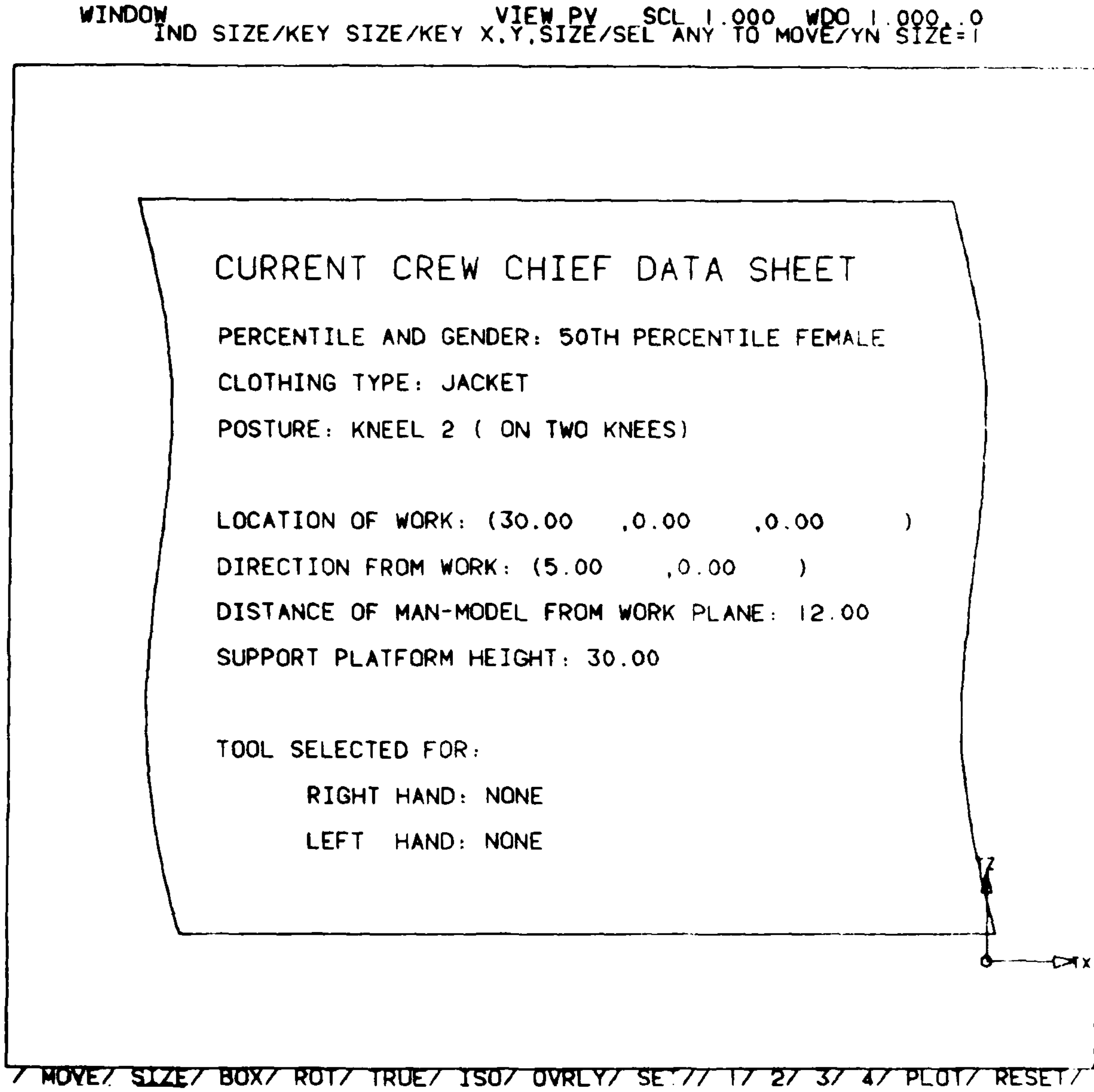


Figure 6.1. Current CREW CHIEF Data Sheet.

After the data sheet appears on the screen, it may be necessary to increase the size of the data sheet to be viewed correctly. This can be accomplished by depressing CADAM's window function key and using the appropriate menu items to view the data sheet. After the user has viewed the plot, he/she should depress the Macro Geometry function key to continue any analysis.

Figure 6.2 diagrams the actions necessary to execute a display of the current CREW CHIEF data.

To continue the analysis, the user will select **/MENU 1/** from bottom of screen. The CREW CHIEF Main Programs menu will appear.

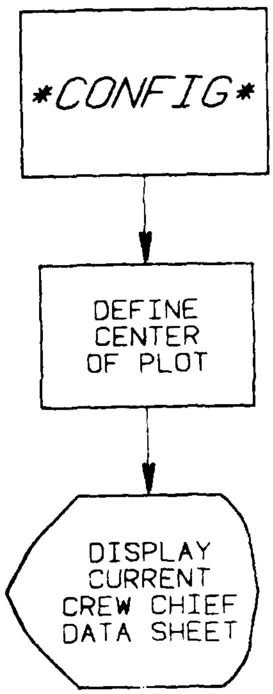


Figure 6.2. Current CREW CHIEF Data Flow Diagram.

SECTION 7

INTERACTIVE HELP CAPABILITIES

7.1 INTRODUCTION TO INTERACTIVE HELP CAPABILITIES

Each CREW CHIEF Macro function includes a series of callable HELP pages, displayed on the screen, to assist in operating the function. These pages give reminders on how to use the function and suggestions concerning the selections to be made, but do not take the place of this user's guide.

The HELP pages cannot be called at will when executing the function. They can only be called when /HELP/ is displayed in the CADAM-supplied bottom menu. (See Section 8.)

Once **/HELP/** has been selected, an index page will be the first page to appear on the screen, and will show the user where the particular item is described. The CADAM HELP capability has one drawback: the user cannot go directly to the desired HELP page, but instead must wait while each page is sequentially displayed on the screen. To view the next HELP page, the user must select **/NEXT PAGE/** from the CADAM-supplied bottom menu.

7.2 USING THE INTERACTIVE HELP CAPABILITIES

To call the set of HELP pages for any function:

PROMPT: (These vary from function to function, and always appear at the top of the window.)

ACTION: Select **/HELP/**, when it is available, from the CADAM-supplied bottom menu. It is available during CADAM's display mode (parameters to be input into the program from the interface appear on the screen) or dialogue mode (allows screen input by keying in, selecting, or indicating)

RESULT: Index page of HELP available for a particular function is displayed.

To view the next page:

PROMPT: SEL MENU (These vary from function to function and prompt appears at top of page)

ACTION: Select **/NEXT PAGE/** from the bottom menu

RESULT: Subsequent page is displayed.

Each succeeding page is accessed by selecting **/NEXT PAGE/**. When the last page is reached, the /NEXT PAGE/ selection will display the index page and the order of HELP pages will begin again. The user exits the HELP mode by selecting **/RETURN/** from the bottom menu. The program returns the user back to his/her previous location in the interface of the particular function. Figures 7.1 through 7.8 are typical examples of HELP pages.

MACRO VIEW PV SCL 1.000 WDO 20.00,.0
SEL MENU

CREW CHIEF INITIALIZATION
HELP TABLE. INDEX.
CREW CHIEF. VERSION I

CREW CHIEF INITIALIZATION HELP PAGES.

<u>SUBJECT</u>	<u>PAGE NUMBER</u>
BODY SIZE	1
GENDER	1
CLOTHING TYPE	2
POSTURES	3
MAN MODEL POSITIONING	4
DISTANCE FROM WORK	5
PLATFORM HEIGHT	6
DISPLAY TYPE	7

SELECT /NEXT PAGE/ TO ADVANCE TO PAGE ONE.

/ RESTART / NEXT PAGE / / MENU 1 / RETURN /

Figure 7-1. Index Page for CREW CHIEF Initialization (CCINIT) Help Pages.

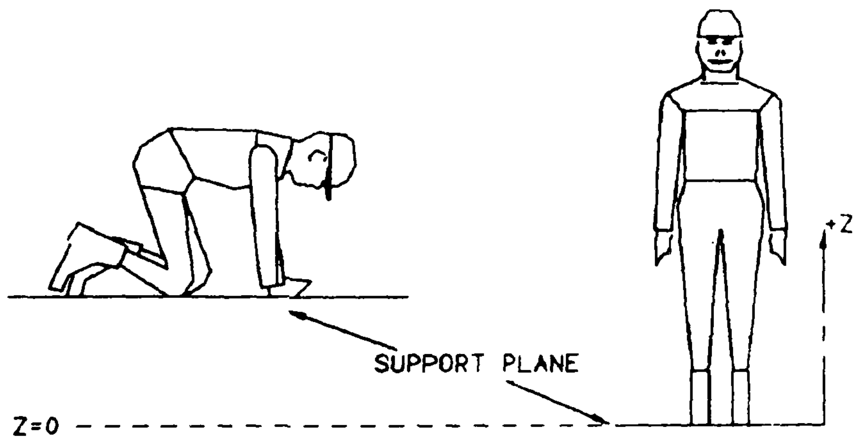
MACRO VIEW PV SCL 1.000 WDO 1.000,.0
SEL MENU

TECHNICIAN PARAMETER
HELP TABLE. PAGE 6.
CREW CHIEF. VERSION I

D) PLATFORM HEIGHT:

THE POSITION ALONG THE Z-AXIS OF THE SUPPORT PLANE

** NOTE: PLATFORM HEIGHT MEASURED FROM Z=0.
THEREFORE CAN BE NEGATIVE.



MORE HELP AVAILABLE ON NEXT PAGE

/ RESTART / NEXT PAGE / / MENU T / RETURN /

Figure 7.2. CREW CHIEF Initialization (CCINIT) Help Page.

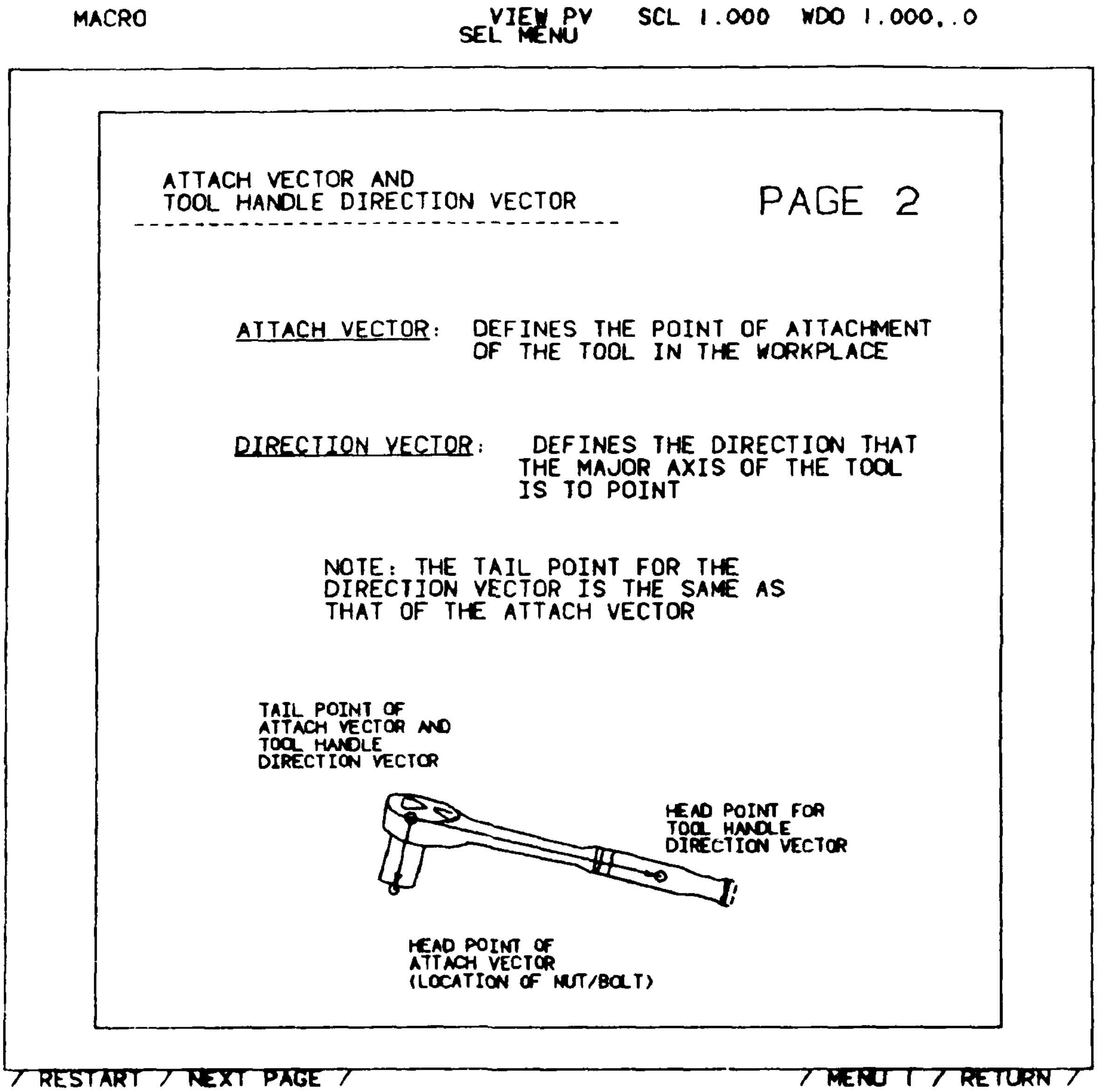


Figure 7.3. CREW CHIEF Tool Analysis (@TOOL) Help Page.

MACRO VIEW PV SEL MENU SCL 1.000 WDO 20.00,.0

MATERIALS HANDLING
HELP TABLE. PAGE 5.
CREW CHIEF, VERSION I

COEFFICIENT OF FRICTION
BETWEEN SHOES AND SURFACE

SURFACE 1	SURFACE 2	μ
RUBBER	RUBBER (WET)	0.5-0.9
RUBBER	RUBBER (DRY)	0.7-1.0
LEATHER	WOOD	0.2-0.5
LEATHER	METAL	0.3-0.6

MORE HELP AVAILABLE ON NEXT PAGE.

/ RESTART / NEXT PAGE / / MENU 1 / RETURN /

Figure 7.4. Coefficient of Friction Help Page.

MACRO VIEW PV SEL MENU SCL 1.000 WDO 20.00,.0

MATERIALS HANDLING
HELP TABLE. PAGE 4
CREWCHIEF, VERSION I

OBJECT DIMENSIONS:

HEIGHT:

OBJECT'S DIMENSION PERPENDICULAR TO THE SUPPORT PLANE

WIDTH:

OBJECT'S HORIZONTAL DIMENSION PARALLEL TO THE CREW CHIEF'S BODY

DEPTH:

OBJECT'S DIMENSION PERPENDICULAR TO THE CREW CHIEF'S BODY

** NOTE: FOR IRREGULAR OBJECTS, OTHER ELEMENTS BESIDES HEIGHT, WIDTH, & DEPTH MAY BE NEEDED TO DEFINE THE OBJECT'S SURFACE.

MORE HELP AVAILABLE ON NEXT PAGE.

/ RESTART / NEXT PAGE / / MENU I / RETURN /

Figure 7.5. Materials Handling Help Page.

MACRO VIEW PV SCL 1.000 WDO 13.07,.0
SEL MENU

VISIBILITY ANALYSIS
HELP TABLE, PAGE 1
CREW CHIEF, VERSION I

VIEWPOINT:

CREWCHIEF'S: VIEW THE WORK STATION FROM CREW CHIEF'S ORIENTATION

INCLUDE MAN/EXCLUDE MAN: CHOOSE THIS TO CHECK FOR BODY PART INTERFERENCE IN THE VIEWING PROCESS.

MORE HELP AVAILABLE ON NEXT PAGE

/ RESTART / NEXT PAGE / / MENU 1 / RETURN /

Figure 7.6. CREW CHIEF Visibility Analysis (VISAN) Help Page.

MACRO VIEW PV SEL MENU SCL 1.000 WDO 20.00,.0

CONNECTOR ANALYSIS
HELP TABLE. PAGE 3.
CREW CHIEF, VERSION I

CENTER OF PLOT

2-DIMENSIONAL CADAM POINT DEFINING WHERE THE CENTER OF THE STRENGTH TABLE WILL APPEAR ON THE SCREEN.

DISPLAY TYPE

WIRE: WIRE FRAME MODEL WILL BE DISPLAYED.

FRONT: WIRE FRAME MODEL WITH BACK FACES REMOVED.

PROFILE: WIRE FRAME MODEL WITH BACK FACES AND INTERIOR LINES REMOVED.

REPOSITION: WIRE FRAME MODEL WITH EXTRA LINE SEGMENTS TO AID REPOSITIONING PROCESS.

END OF HELP FOR CONNECTOR ANALYSIS

/ RESTART / NEXT PAGE / / MENU T / RETURN /

Figure 7.7. Connector Analysis Help Page.

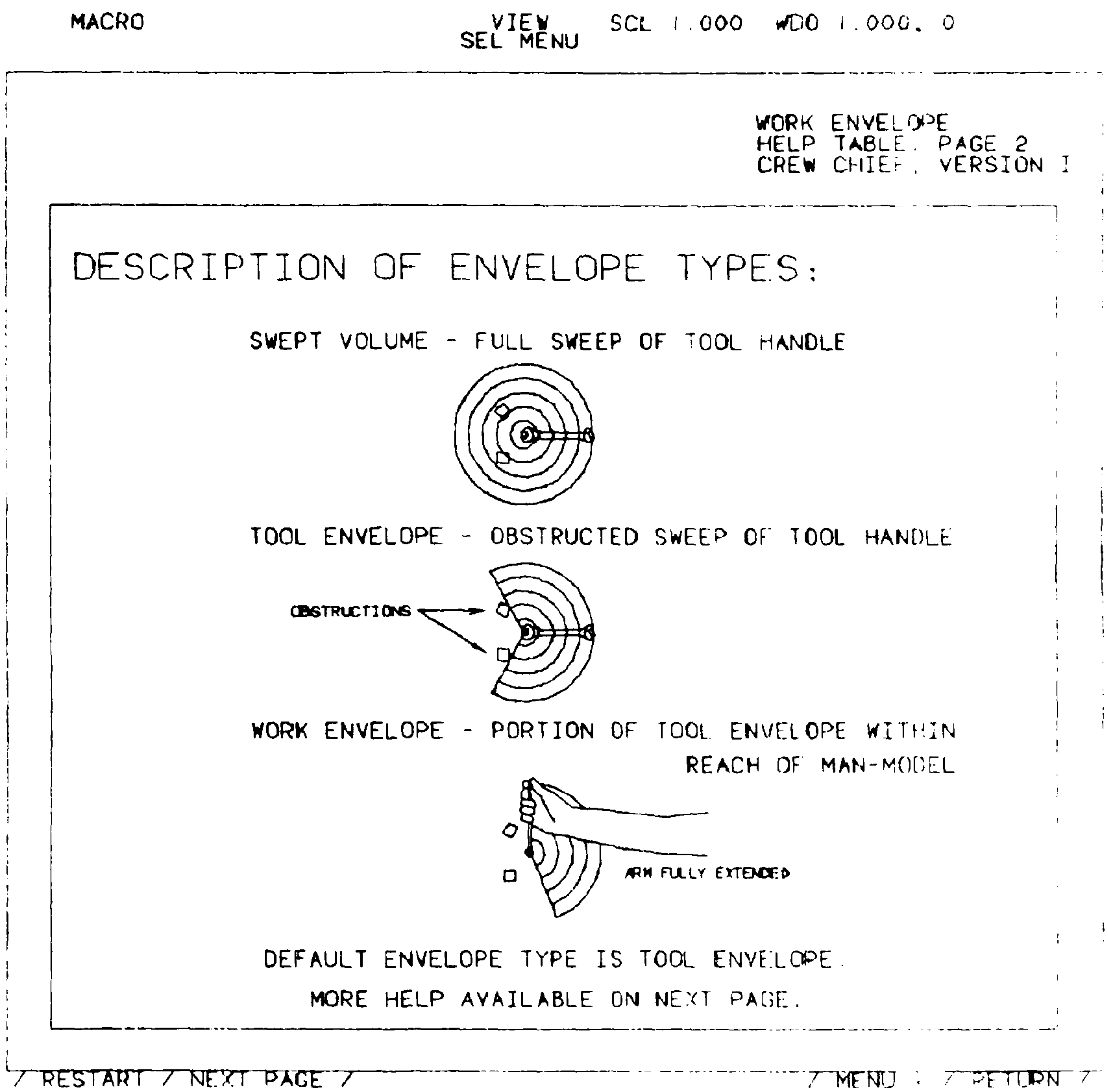


Figure 7.8. Work Envelope Help Table Depicting Differences Between Work Envelope Types.

SECTION 8

CADAM-SUPPLIED MENUS

8.1 INTRODUCTION TO CADAM-SUPPLIED MENUS

This section explains menu options supplied automatically during the user interface of a particular function. These options are in the form of a bottom menu and are referred to in this user's guide as CADAM-supplied menus. The menu options described in the next section are in the form of two menus:

- /EXECUTE/RESTART/HELP/OLD PARM/RETURN/
- /RESTART/SAVE/SAVE + RESTART/MENU 1/

(See Reference 5.)

8.2 DESCRIPTION OF CADAM-SUPPLIED MENU OPTIONS

The following is a description of each item found in the menu /EXECUTE/RESTART/HELP/OLD PARM/RETURN/.

/EXECUTE/	- allows the user to accept the currently defined parameters on the screen (see Figure 5.2 for an example) and executes the rest of the functions
/RESTART/	- causes the parameters on the screen (see Figure 5.2 for an example) to be reset to their default values
/HELP/	- allows the user to have access to the HELP pages
/OLD PARM/	- the parameters displayed on the screen (see Figure 5.2 for an example) will be reset as they were before /EXECUTE/ was selected

/RETURN/ - returns the user to the previous menu (the menu before the display page)

The following describes each item found in the menu:

/RESTART/SAVE/SAVE + RESTART/MENU/

/RESTART/ - returns the user to the display page (see Figure 5.2 for an example) and the parameters are reset to their default values

/SAVE/ - any geometry (i.e., man-model) created in the drawing during the execution of the function is saved as a part of the drawing; the program returns the user to the previous menu (the menu before the display page)

<u>CAUTION:</u> A warning is given to the user at this time. If the man-model is saved in the drawing and is not erased, the next function executed will consider the man-model as elements in the drawing and will not interpret these as the man-model elements. This can cause problems when trying to evaluate the man-model performing a specific task in a work area.

/SAVE + RESTART/ - any geometry (i.e., man-model) created in the drawing during the execution of the function is saved as a part of the drawing. The program returns the user to the display page (see Figure 5.2 for an example) and parameters are reset to their default values.

NOTE: See CAUTION given previously.

/MENU/ - returns the user to the previous menu (the menu before the display page)

SECTION 9

QUICK REFERENCE

This Quick Reference Section is provided as an outline of the actions which can be taken for any given function. The Section is divided into each of the eleven different functions. All function prompts begin from the CREW CHIEF Main Programs menu (Figure 1.3). All prompts appear at the top of the window and all menus appears either on the screen or at the bottom of the window.

9.1 CREW CHIEF GENERATION FUNCTIONS (@CCGEN)

9.1.1 CREW CHIEF Initialization Function (CCINIT)

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@CCGEN*** from menu

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE

ACTION: Select ***CCINIT*** from the menu

RESULT: Technician Definition menu (Figure 2.2) is displayed

PROMPT 3: KEY IN BODY-SIZE GENDER INDEX NUMBER FROM ABOVE LIST (1-10) . . . . .INDEX = N

ACTION: Key in man-model's body-size and gender (see Appendix A) **<CR>**

RESULT: Index value changes to keyed-in value.

PROMPT 4: KEY IN CLOTHING INDEX NUMBER FROM ABOVE LIST (1-4) . . . . . CLOTHG = N

ACTION: Key in man-model's clothing type (see Appendix B) **<CR>**

RESULT: Clothing value changes to keyed-in value.

PROMPT 5: KEY IN POSTURE INDEX NUMBER FROM ABOVE LIST (1-12) . . . . POSTUR = N

ACTION: Key in man-model's starting posture (see Appendix C) **<CR>**

RESULT: Posture value changes to keyed-in value

PROMPT 6: TECHNICIAN DEFINITION: WHEN THE ABOVE DEFINITIONS ARE COMPLETE, SELECT /EXECUTE/ FROM THE MENU BELOW

ACTION: Select **/EXECUTE/** from bottom menu

RESULT: Drawing reappears on screen and menu to select input mode for technician positioning appears

PROMPT 7: SEL MENU

ACTION 1: Select **/SELECT-KEY IN/** from bottom menu

RESULT: Prompt to define location of work appears

ACTION 2: Select **/SAME/** from bottom menu

RESULT: Display Type Selection menu appears (Go to Prompt 14)

PROMPT 8: SEL MENU/YN REJECT/<u>DEFINE LOCATION OF WORK</u>

ACTION: Select an existing 3-D point of the location of work <u>or</u> key in the X,Y,Z coordinates of the location of work **<CR>**

RESULT: Prompt for direction of man-model to work appears.

PROMPT 9: SEL MENU/YN REJECT/<u>DEFINE DIRECTION OF MAN TO WORK</u>

ACTION: Select an existing point to define the direction point <u>or</u> key in the X,Y,Z coordinates of the direction point **<CR>**

RESULT: Prompt to key in distance from work appears.

PROMPT 10: SEL MENU/YN REJECT/<u>KEY IN DISTANCE FROM WORK</u>

ACTION: Key in distance from work **<CR>**

RESULT: Menu for defining mode to input platform height appears.

PROMPT 11: SEL MENU

ACTION 1: Choose **/SELECT PLATFORM HGT/** from bottom menu

RESULT: Prompt to select platform height from drawing appears (Go to Prompt 12)

ACTION 2: Select **/KEY IN PLATFORM HGT/** from bottom menu

RESULT: Prompt to key in platform height appears. (Go to Prompt 13.)

PROMPT 12: SEL MENU/YN REJECT/<u>DEFINE PLATFORM HEIGHT</u>

ACTION: Select an existing 3-D point (Z coordinate)

RESULT: Display Type menu appears. (Go to Prompt 14.)

PROMPT 13: SEL MENU/YN REJECT/<u>KEY IN PLATFORM HGT</u>

ACTION: Key in platform height (Z coordinate) **<CR>**

RESULT: Display Type menu appears.

PROMPT 14: SEL MENU

ACTION: Select a display type (see Table 2.1) from bottom menu

RESULT 1: Man-model appears superimposed on the drawing in size-gender, posture, clothing, and display type chosen; a CADAM menu appears. (Go to Prompt 16.)

RESULT 2: CADAM menu appears (Result of selecting instead of keying in platform height)

PROMPT 15: YN SAME/<u>SEL MENU</u>

ACTION: Select **/EXECUTE/** from menu

RESULT: Man-model appears superimposed on the drawing in size-gender, posture, clothing, and display type chosen; a CADAM menu appears.

PROMPT 16: SEL MENU

ACTION: Select **/MENU 1/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1) without saving the current man-model

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

9.1.2 <u>CREW CHIEF Regeneration Function (REGEN)</u>

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@CCGEN*** from menu

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE

ACTION: Select ***REGEN*** from menu

RESULT: Display type menu appears.

PROMPT 3: SEL MENU

ACTION: Select a display type (see Table 2.1)

RESULT: Man-model appears on the drawing in the display type chosen and as it did in the last successful generation; a CADAM menu appears.

PROMPT 4: SEL MENU

ACTION: Select **/MENU 1/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1) without saving the current man-model

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

9.1.3 CREW CHIEF Reposition Function (REPOSN)

(Not available at this time.)

9.1.4 CREW CHIEF Head Orientation Function (HDORT)

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@CCGEN*** from the menu

RESULT: CREW CHIEF Generation Functions menu (Figure 2.1) is displayed.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE GENERATION FUNCTION YOU WISH TO USE

ACTION: Select ***HDORT*** from the menu

RESULT: Prompt to define target point appears.

PROMPT 3: SEL MENU/YN REJECT/<u>DEFINE TARGET POINT</u>

ACTION: Select an existing 3-D point to define the target point <u>or</u> key in X,Y,Z coordinates of the target point **<CR>**

RESULT: Display type menu appears.

PROMPT 4: SEL MENU

ACTION: Select a display type (see Table 2.1)

RESULT: A CADAM menu appears.

PROMPT 5: YN SAME OR SEL MENU

ACTION: Select **/EXECUTE/** from bottom menu

RESULT: Man-model appears superimposed in the display type chosen, with its head oriented toward the target point; CADAM menu appears.

PROMPT 6: SEL MENU

ACTION: Select **/MENU 1/** to return to the CREW CHIEF Generation Functions menu (Figure 2.1) without saving the current man-model

RESULT: Program returns to CREW CHIEF Generation Functions menu (Figure 2.1).

9.2 MAINTENANCE TASK ANALYSES (@TSKAN)

9.2.1 CREW CHIEF Tool Analysis Function (@TOOL)

9.2.1.1 Wrenches Without Sockets: Open End, Combination End, Standard Box End, Deep Offset Box End, Ratcheting Box End, and Allen

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool Selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select ***@WRENCHES** from menu

RESULT: Wrench Selection menu (Figure 3.3) appears.

PROMPT 4: SELECT THE TYPE OF WRENCH YOU WISH TO USE

ACTION: Select a type of wrench from the menu

RESULT: Bolt diameter menu appears.

PROMPT 5: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WISH TO USE

ACTION: Select the abbreviation corresponding to bolt diameter to be used in the analysis

RESULT 1: Hand and Grip Type Selection menu appears.

RESULT 2: Hand, Grip, and End Type Selection menu appears (Result of choosing combination end wrench). (Go to Prompt 8.)

PROMPT 6: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP TYPE YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand(s) chosen will be indicated on the screen by "YES".

PROMPT 7: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP TYPE</u> YOU WISH TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES". (Go to Prompt 11.)

PROMPT 8: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u>, GRIP AND END TYPE YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand(s) chosen will be indicated on the screen by "YES".

PROMPT 9: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND, <u>GRIP</u> AND END TYPE YOU WISH TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES".

PROMPT 10: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND, GRIP AND <u>END TYPE</u> YOU WANT TO USE

ACTION: Select which end of combination end wrench is to be used

RESULT: End type chosen will be indicated on the screen by "YES".

PROMPT 11: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when hand and grip type (and end type if combination end wrench is selected) selections are complete

RESULT: Drawing reappears on screen and prompt to define head point of attach vector appears.

PROMPT 12: SEL MENU/YN REJECT/DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the bolt head <u>or</u> key in X,Y,Z coordinates which define center point of bolt head **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 13: SEL MENU/YN REJECT/<u>DEFINE TAIL POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the orientation of bolt axis <u>or</u> key in the X,Y,Z coordinates of bolt axis

RESULT: Prompt to define direction of tool handle appears.

PROMPT 14: SEL MENU/YN REJECT/<u>DEFINE DIRECTION OF TOOL HANDLE</u>

ACTION: Select an existing 3-D point to define the tool handle direction <u>or</u> key in X,Y,Z coordinates of handle direction point **<CR>**

RESULT: Menu for mobility types appears.

PROMPT 15: SEL MENU

ACTION: Select from bottom menu one of the mobility types to be used during the Reach analysis

RESULT: Prompt for center of plot appears.

PROMPT 16: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen.

RESULT: Menu for obstacle avoidance appears.

PROMPT 17: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display Type menu appears.

PROMPT 18: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT: CADAM menu appears.

PROMPT 19: YN SAME/SEL MENU

ACTION: Select **/EXECUTE/** from bottom menu

RESULT 1: If task is successful, man-model appears on the drawing performing the task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 20: SEL MENU

ACTION: Select **/MENU 1/** from bottom menu to continue any analysis without saving current man-model

RESULT: Bolt Diameter menu appears.

9.2.1.2 Wrenches With Sockets: Breaker Bar, Torque, Ratchet, and Speedhandle

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool Selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select ***@WRENCHES** from menu

RESULT: Wrench selection menu (Figure 3.3) appears.

PROMPT 4: SELECT THE TYPE OF WRENCH TYPE YOU WISH TO USE

ACTION: Select a type of wrench (Figure 3.3) from menu

RESULT: Bolt Diameter menu appears.

PROMPT 5: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WISH TO USE

ACTION: Select the abbreviation corresponding to bolt diameter to be used in analysis

RESULT: Tool Handle Lengths Selection menu appears.

PROMPT 6: SELECT THE TOOL LENGTH YOU WISH TO USE

ACTION: Select the abbreviation corresponding to the length of the wrench handle (regular or long) to be used in the analysis

RESULT: Hand and Grip Type Selection menu appears.

PROMPT 7: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand(s) chosen will be indicated on the screen by "YES".

PROMPT 8: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND GRIP YOU WANT TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on the screen by "YES".

PROMPT 9: SEL VARIABLE/KEY PARM/SEL MENU/YN NEXT/

ACTION: Select **/EXECUTE/** from bottom menu after hand and grip selections are completed

RESULT: Drawing reappears on screen and menu for extension length appears.

PROMPT 10: SEL MENU

ACTION: Select desired extension length from bottom menu

RESULT: Socket type menu appears.

PROMPT 11: SEL MENU

ACTION: Select desired socket type from bottom menu

RESULT: Prompt for head point of attach vector appears.

PROMPT 12: SEL MENU/YN REJECT/<u>DEFINE HEAD POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the center point of bolt head or key in X,Y,Z coordinates which define center point of bolt head **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 13: SEL MENU/YN REJECT/<u>DEFINE TAIL POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the orientation of the bolt axis or key in the X,Y,Z coordinates to define the orientation of the bolt axis **<CR>**

RESULT: Prompt to define direction of tool handle appears.

PROMPT 14: SEL MENU/YN REJECT/<u>DEFINE DIRECTION OF TOOL HANDLE</u>

ACTION: Select an existing 3-D point to define the tool handle direction <u>or</u> key in X,Y,Z coordinates of the tool handle direction point **<CR>**

RESULT: Menu for mobility types appears.

PROMPT 15: SEL MENU

ACTION: Select from bottom menu one of mobility types to be used during the Reach analysis

RESULT 1: Prompt for center of plot appears (if wrench has a torque table to be displayed).

RESULT 2: Menu for obstacle avoidance appears. (Go to Prompt 17.)

PROMPT 16: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a 2-D point to determine where the center of the strength-related measurements table will appear on the screen

RESULT: Menu for obstacle avoidance appears.

PROMPT 17: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 18: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT 1: If task is successful, man-model along with table (if applicable) appears on the drawing performing the task; CADAM menu appears.

RESULT 2: If task is unsuccessful because the distance from the man-model to the task is too great, then man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 19: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving the current man-model

RESULT: Tool Handle Lengths menu appears.

9.2.1.3 Nutdriver

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select ***@NUTDRIVER** from menu

RESULT: Bolt Diameter menu (Figure 3.11) appears.

PROMPT 4: SELECT THE ABBREVIATION UNDER THE BOLT DIAMETER YOU WANT TO USE

ACTION: Select the abbreviation corresponding to bolt diameter to be used in analysis

RESULT: Hand and Grip Type Selection menu (Figure 3.12) appears.

PROMPT 5: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand chosen will be indicated on screen by "YES".

PROMPT 6: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP</u> YOU WANT TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES".

PROMPT 7: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu after hand and grip type selections are complete

RESULT: Prompt for head point of attach vector appears.

PROMPT 8: SEL MENU/YN REJECT/<u>DEFINE HEAD POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the center point of nut <u>or</u> key in X,Y,Z coordinates which define center of nut **<CR>**

RESULT: Prompt to define tail point to attach vector appears.

PROMPT 9: SEL MENU/YN REJECT/<u>DEFINE TAIL POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the orientation of the nut axis or key in the X,Y,Z coordinates to define the orientation of the nut axis **<CR>**

RESULT: Menu for mobility types appears.

PROMPT 10: SEL MENU

ACTION: Select from bottom menu one of mobility types to use during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 11: SEL MENU

ACTION: Select from bottom menu one of the obstacle avoidance choices

RESULT: Display type menu appears.

PROMPT 12: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT: CADAM menu appears.

PROMPT 13: YN SAME / SEL MENU

ACTION: Select **/EXECUTE/** from bottom menu

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because the distance from the man-model to the task is too great, the man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 14: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving current man-model

RESULT: Bolt Diameter menu appears.

9.2.1.4 Screwdrivers

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select ***@SCREWDRIVER** from menu

RESULT: Screwdriver Selection menu (Figure 3.14) appears.

PROMPT 4: SELECT THE TYPE OF SCREWDRIVER YOU WISH TO USE

ACTION 1: Select ***@REGULAR** from menu

RESULT: Blade Lengths Selection menu (Figure 3.15) appea

ACTION 2: Select ***OFFSET** from menu

RESULT: Hand, Grip Type, and Length selection menu appears. (Go To Prompt 8.)

PROMPT 5: SELECT THE ABBREVIATION UNDER THE BLADE LENGTH YOU WISH TO USE

ACTION: Select blade length to be used in the analysis (Figure 3.15)

RESULT: Hand and Grip Type Selection menu (Figure 3.16) appears.

PROMPT 6: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand chosen will be indicated on screen by "YES".

PROMPT 7: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP</u> YOU WANT TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES". (Go to Prompt 11.)

PROMPT 8: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u>, GRIP, AND LENGTH YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand chosen will be indicated on screen by "YES".

PROMPT 9: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND, <u>GRIP</u>, AND LENGTH YOU WANT TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES".

PROMPT 10: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND, GRIP, AND <u>LENGTH</u> YOU WANT TO USE

ACTION: Select the length to be used

RESULT: Length chosen will be indicated on screen by "YES".

PROMPT 11: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu after hand and grip type selections are complete

RESULT: Prompt for head point of attach vector appears.

PROMPT 12: SEL MENU/YN REJECT/<u>DEFINE HEAD POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 13: SEL MENU/YN REJECT/<u>DEFINE TAIL POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the orientation of the screw axis or key in the X,Y,Z coordinates to define the orientation of the screw axis **<CR>**

RESULT 1: Mobility Type Selection menu appears (Result of choosing REGULAR screwdriver). (Go to Prompt 15.)

RESULT 2: Prompt to define direction of tool handle appears (Result of choosing OFFSET screwdriver).

PROMPT 14: SEL MENU/YN REJECT/<u>DEFINE DIRECTION OF TOOL HANDLE</u>

ACTION: Select an existing 3-D point to define the direction of tool handle or key in the X,Y,Z coordinates to define the direction of the tool handle **<CR>**

RESULT: Mobility Type Selection menu appears.

PROMPT 15: SEL MENU

ACTION: Select from bottom menu one of the mobility types to use during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 16: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display Type menu appears.

PROMPT 17: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT: CADAM menu appears.

PROMPT 18: YN SAME/<u>SEL MENU</u>/

ACTION: Select **/EXECUTE/** from menu

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 19: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving current man-model

RESULT: Blade length menu (Figure 3.15) appears.

9.2.1.5 Pliers

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool Selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select ***@PLIERS** from menu

RESULT: Pliers Selection menu (Figure 3.18) appears.

PROMPT 4: SELECT THE TYPE OF PLIERS YOU WISH TO USE

ACTION: Select the type of pliers to be used in the analysis from menu

RESULT: Hand and Grip Type Selection menu appears.

PROMPT 5: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE <u>HAND</u> AND GRIP YOU WANT TO USE

ACTION: Select which hand will hold the tool

RESULT: Hand chosen will be indicated on screen by "YES".

PROMPT 6: SELECT THE LABEL NAME WHICH CORRESPONDS TO THE HAND AND <u>GRIP</u> YOU WANT TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES".

PROMPT 7: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu after hand and grip type selections are complete

RESULT: Prompt for head point of attach vector appears.

PROMPT 8: SEL MENU/YN REJECT/<u>DEFINE HEAD POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 9: SEL MENU/YN REJECT/<u>DEFINE TAIL POINT OF ATTACH VECTOR</u>

ACTION: Select an existing 3-D point to define the direction of the point of attachment or key in the X,Y,Z coordinates to define the direction of the point of attachment **<CR>**

RESULT: Prompt to define direction of tool handle appears.

PROMPT 10: SEL MENU/YN REJECT/<u>DEFINE DIRECTION OF TOOL HANDLE</u>

ACTION: Select an existing 3-D point to define the direction of tool handle or key in X,Y,Z coordinates of the direction of tool handle **<CR>**

RESULT: Mobility Type menu appears.

PROMPT 11: SEL MENU

ACTION: Select from bottom menu one of the mobility types to use during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 12: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display Type menu appears.

PROMPT 13: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT: CADAM menu appears.

PROMPT 14: YN SAME/<u>SEL MENU/</u>

ACTION: Select **/EXECUTE/** from menu

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appears.

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 15: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving current man-model

RESULT: Tool Selection menu (Figure 3.2) appears.

9.2.1.6 Miscellaneous Tools

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***@TOOL*** from menu

RESULT: Tool Selection menu (Figure 3.2) is displayed.

PROMPT 3: SELECT THE TYPE OF TOOL YOU WISH TO USE

ACTION: Select one of the following tools: **HAMMER**, **CHISEL/HAMMER**, **FILE**, **SCRAPER**, **HACKSAW**, **DRILL**, or **SANDER**

RESULT: Menu to select which hand will hold the tool appears.

PROMPT 4: SEL MENU

ACTION: Select which hand will hold the tool from bottom menu

RESULT: Prompt for head point of attach vector appears.

PROMPT 5: SEL MENU/YN REJECT/DEFINE HEAD POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the center point of attachment or key in X,Y,Z coordinates which define center point of attachment **<CR>**

RESULT: Prompt to define tail point of attach vector appears.

PROMPT 6: SEL MENU/YN REJECT/DEFINE TAIL POINT OF ATTACH VECTOR

ACTION: Select an existing 3-D point to define the direction of the point of attachment or key in the X,Y,Z coordinates to define the direction of the point of attachment **<CR>**

RESULT 1: Prompt to define direction of tool handle appears.

RESULT 2: Mobility type menu appears. (Result of choosing File or Scraper.) (Go to prompt 8.)

PROMPT 7: SEL MENU/YN REJECT/DEFINE DIRECTION OF TOOL HANDLE

ACTION: Select an existing 3-D point to define the direction of tool handle or key in X,Y,Z coordinates of the direction of tool handle **<CR>**

RESULT: Mobility Type menu appears.

PROMPT 8: SEL MENU

ACTION: Select from bottom menu one of the mobility types to use during the Reach analysis

RESULT: Menu for obstacle avoidance appears.

PROMPT 9: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display Type menu appears.

PROMPT 10: SEL MENU

ACTION: Select one of the display types (Table 2.1)

RESULT: CADAM menu appears.

PROMPT 11: YN SAME/SEL MENU/

ACTION: Select **/EXECUTE/** from menu

RESULT 1: If task is successful, man-model appears on the drawing performing task; CADAM menu appear

RESULT 2: If task is unsuccessful because distance from man-model to task is too great, man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 12: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving current man-model

RESULT: Tool Selection menu (Figure 3.2) appears.

9.2.2 Materials Handling Analysis Function (MMH)

9.2.2.1 Carry

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTIONS YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***CARRY*** from menu

RESULT: Handle Selection menu appears.

PROMPT 4: SEL MENU

ACTION 1: Select **/NO HANDLE/** from bottom menu

RESULT: Menu to select mode for defining ceiling height appears. (Go to Prompt 7.)

ACTION 2: Select **/HANDLES <CRAWL POSTURE ONLY>/** from bottom menu

RESULT: Menu to select number of handles appears.

PROMPT 5: SEL MENU

ACTION 1: Select **/ONE/** from bottom menu

RESULT: Hand Selection menu appears.

ACTION 2: Select **/TWO/** from bottom menu

RESULT: Menu to select mode for defining ceiling height appears. (Go to Prompt 7.)

PROMPT 6: SEL MENU

ACTION: Select which hand will grasp the handle

RESULT: Mode for defining ceiling height appears.

PROMPT 7: SEL MENU

ACTION 1: Select **/SELECT/** from bottom menu

RESULT: Prompt to select ceiling height appears. (Go to Prompt 9.)

ACTION 2: Select **/KEY IN/** from bottom menu

RESULT: Prompt to key in ceiling height appears.

PROMPT 8: SEL MENU/YN REJECT/KEY IN CEILING HEIGHT

ACTION: Key in value which represents ceiling height **<CR>**

RESULT: Prompt to key in object height appears. (Go to Prompt 10.)

PROMPT 9: SEL MENU/YN REJECT/SELECT ELEMENT TO DEFINE CEILING HEIGHT

ACTION: Select element (line or 2-point spline) in drawing to represent ceiling height

RESULT: Prompt to key in object height appears.

PROMPT 10: SEL MENU/YN REJECT/KEY IN OBJECT HEIGHT

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 11: SEL MENU/YN REJECT/KEY IN OBJECT WIDTH

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 12: SEL MENU/YN REJECT/KEY IN OBJECT DEPTH

ACTION: Key in value representing depth of object **<CR>**

RESULT: Prompt to indicate Center of Plot Table appears.

PROMPT 13: SEL MENU/YN REJECT/INDICATE CENTER OF PLOT

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 14: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 15: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If carry is successful, man-model along with strength table appears on the drawing in the final carry position; CADAM menu appears.

RESULT 2: If carry is unsuccessful because the distance from the man-model to the object is too great, then man-model appears on drawing attempting to perform carry; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the element selected to define a ceiling was not a line segment or a two-point spline, then the CARRY Task is abandoned and the message "ILLEGAL ELEMENT SELECTED" appears.

RESULT 5: If the line selected to define the ceiling height is parallel to the plane which bisects the man-model into right and left halves, then no intersection point can be found, the ceiling height remains undefined, the CARRY Task is abandoned, and the message "LINE DEFINING CEILING DOES NOT CROSS MAN-MODEL PATH" appears.

RESULT 6: If the object height is greater than the ceiling height, then the CARRY Task is abandoned and the message "OBJECT DOES NOT FIT UNDER CHOSEN CEILING" appears.

RESULT 7: If the ceiling height is less than thirty percent of the current man-model's stature, then no data have been gathered for the chosen ceiling height and the message "CEILING TOO LOW RELATIVE TO CURRENT MAN-MODEL SIZE" appears.

PROMPT 16: SEL MENU

ACTION: Select **/MENU 1/** to return to the Materials Handling Tasks menu without saving the current man-model

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

9.2.2.2 Hold

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analysis Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***HOLD*** from menu

RESULT: The Arm, Mobility, and Hold Task Type Selection menu (Figure 3.24) appears.

PROMPT 4: SELECT <u>ARM TYPE</u>, MOBILITY TYPE, AND HOLD TASK TYPE YOU WISH TO USE

ACTION: Select which arm will hold the object

RESULT: Arm chosen will be indicated on the screen by "YES".

PROMPT 5: SELECT ARM TYPE, <u>MOBILITY TYPE</u>, AND HOLD TASK TYPE YOU WISH TO USE

ACTION: Select one of the mobility types to be used during the Reach Analysis

RESULT: Mobility type chosen will be indicated on screen by "YES".

PROMPT 6: SELECT ARM TYPE, MOBILITY TYPE, AND <u>HOLD TASK TYPE</u> YOU WISH TO USE

ACTION: Select which Hold Task Type to use during the analysis

RESULT: Hold Task Type chosen will be indicated on screen by "YES".

PROMPT 7: SEL VARIABLE / KEY PARM / <u>SEL MENU</u> / YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when Arm, Mobility, and Hold Task Type selections are complete

RESULT 1: Drawing reappears and menu to select a barrier appears (Result of choosing AGAINST WALL).

RESULT 2: Drawing reappears and menu for selecting mode for defining object dimensions appears (Result of choosing AGAINST CEILING). (Go to Prompt 12.)

PROMPT 8: SEL MENU

ACTION 1: Choose **/NONE/** from bottom menu

RESULT: Menu to select mode for object dimensions appears. (Go to Prompt 12.)

ACTION 2: Choose **/VERTICAL/** from bottom menu

RESULT: Menu to select mode for object dimensions appears. (Go to Prompt 12.)

ACTION 3: Choose **/CEILING/** from bottom menu

RESULT: Menu to select mode for defining ceiling height appears.

PROMPT 9: SEL MENU

ACTION 1: Choose **/SELECT/** from bottom menu

RESULT: Prompt to select ceiling height appears. (Go to Prompt 11.)

ACTION 2: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in ceiling height appears.

PROMPT 10: SEL MENU / YN REJECT / <u>KEY IN CEILING HEIGHT</u>

ACTION: Key in value which represents the ceiling height

RESULT: Menu to select mode for object dimensions appears. (Go to Prompt 12.)

PROMPT 11: SEL MENU / YN REJECT / <u>SELECT ELEMENT TO DEFINE CEILING HEIGHT</u>

ACTION: Select element from screen which represents the ceiling height

RESULT: Menu to select mode for object dimensions appears.

PROMPT 12: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in object height appears. (Go to Prompt 17.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select object height appears.

PROMPT 13: SEL MENU / YN REJECT / <u>SELECT ELEMENT TO DEFINE OBJECT HEIGHT</u>

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 14: SEL MENU / YN REJECT / <u>SELECT ELEMENT TO DEFINE OBJECT WIDTH</u>

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 15: SEL MENU / YN REJECT / <u>SELECT ELEMENT TO DEFINE OBJECT DEPTH</u>

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 16: SEL MENU / YN REJECT / <u>SELECT OTHER ELEMENTS FOR OBJECT SURFACE</u>

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 24.)

PROMPT 17: SEL MENU / YN REJECT / <u>KEY IN OBJECT HEIGHT</u>

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 18: SEL MENU / YN REJECT / <u>KEY IN OBJECT WIDTH</u>

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 19: SEL MENU / YN REJECT / <u>KEY IN OBJECT DEPTH</u>

ACTION: Key in value representing depth of object **<CR>**

RESULT 1: Prompt to select line defining height direction appears. (Result of selecting AGAINST WALL.) (Go to Prompt 21.)

RESULT 2 Prompt to select line defining depth direction appears. (Result of selecting AGAINST CEILING.)

PROMPT 20: SEL MENU / YN REJECT / <u>SELECT LINE DEFINING DEPTH DIRECTION</u>

ACTION: Select a line in the drawing which defines the direction of the depth dimension of the object

RESULT: Prompt to select Line 2 of attach plane appears. (Go to Prompt 22.)

PROMPT 21: SEL MENU / YN REJECT / <u>SELECT LINE DEFINING HEIGHT DIRECTION</u>

ACTION: Select a line in the drawing which defines the direction of the height dimension of the object

RESULT: Prompt to select Line 2 of attach plane appears.

PROMPT 22: SEL MENU / YN REJECT / <u>SELECT LINE 2 TO DEFINE ATTACH PLANE</u>

ACTION: Select element in the drawing to represent second line defining attach plane

RESULT: Prompt to define attach point of object appears.

PROMPT 23: SEL MENU / YN REJECT / <u>DEFINE ATTACH POINT OF THE OBJECT</u>

ACTION: Select an existing 3-D point to define coordinates of the object's attach point, or key in X,Y,Z coordinates of object's attach point **<CR>**

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 24: SEL MENU / YN REJECT / <u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 25: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 26: SEL MENU

ACTION: Select one of the display types (Table 2.1) from the bottom menu

RESULT 1: If hold is successful, man-model along with strength table appear on the drawing in the final hold position; CADAM-supplied menu appears.

RESULT 2: If hold is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing attempting to perform hold; missed distance appears on screen; CADAM-supplied menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM-supplied menu appears.

RESULT 4: If a line segment chosen for defining the ceiling height runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; thus the ceiling height remains undefined and the message "LINE DEFINING CEILING HEIGHT DOES NOT INTERSECT MAN-MODEL PLANE" appears.

RESULT 5: If the ceiling and/or the current posture combination does not relate to the current strength data, the Hold task is abandoned and the message "POSTURE AND OBJECT HEIGHT NOT COMPATIBLE WITH PRESENT DATA" appears.

RESULT 6: If any part of the object lies above the ceiling, then the Hold task is abandoned and the message "TOP OF OBJECT GREATER THAN THE USER INPUT CEILING HEIGHT" appears.

RESULT 7: If any one of the object dimensions input is <1 inch, then the Hold task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR THIS SIZE OBJECT" appears.

RESULT 8: If the user has selected or created an object which is impossible for the man-model to reach, then the Hold task is abandoned and the message "SELECTED OBJECT DEFINES DISTANCES TOO LARGE TO REACH" appears.

RESULT 9: If the user picks two line segments which run in the same direction (or exactly opposite directions) to define the attach plane for the object, then the HOLD Task is abandoned and the message "ATTACH PLANE DEFINED IMPROPERLY" appears.

PROMPT 27: SEL MENU

ACTION: Select **/MENU1/** to return to the Materials Handling menu without saving the current man-model

RESULT: Materials Handling menu (Figure 3.22) appears.

9.2.2.3 Lift

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***LIFT*** from menu

RESULT: The Arm, Mobility, and Handle Type Selection menu (Figure 3.26) appears.

PROMPT 4: SELECT <u>ARM TYPE</u>, MOBILITY TYPE AND HANDLE TYPE YOU WISH TO USE

ACTION: Select which arm will lift the object

RESULT: Arm(s) chosen will be indicated on the screen by "YES".

PROMPT 5: SELECT ARM TYPE, <u>MOBILITY TYPE</u> AND HANDLE TYPE YOU WISH TO USE

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Mobility type chosen will be indicated on screen by "YES".

PROMPT 6: SELECT ARM TYPE, MOBILITY TYPE AND <u>HANDLE TYPE</u> YOU WISH TO USE

ACTION: Select handle type to be used

RESULT: Handle type chosen will be indicated on screen by "YES".

PROMPT 7: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when arm, mobility, and handle type selections are complete

RESULT: Drawing reappears and menu for selecting mode for defining object dimensions appears.

PROMPT 8: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in object height appears. (Go to Prompt 13.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select object height appears.

PROMPT 9: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT HEIGHT</u>

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 10: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT WIDTH</u>

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 11: SEL MENU/YN REJECT/SELECT ELEMENT TO DEFINE OBJECT DEPTH

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 12: SEL MENU/YN REJECT/SELECT OTHER ELEMENTS FOR OBJECT SURFACE

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT 1: Prompt to define End Point 1 of handle appears (Result of choosing a handle). (Go to Prompt 20.)

RESULT 2: Prompt to indicate Center of Plot Table appears. (Go to Prompt 22.)

PROMPT 13: SEL MENU/YN REJECT/KEY IN OBJECT HEIGHT

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 14: SEL MENU/YN REJECT/KEY IN OBJECT WIDTH

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 15: SEL MENU/YN REJECT/KEY IN OBJECT DEPTH

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu for selecting mode to define lift distance appears.

PROMPT 16: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in lift distance appears (Go to Prompt 18).

ACTION 2: Choose **/SELECT SHELF/** from bottom menu

RESULT: Prompt to select lift distance from screen appears.

PROMPT 17: SEL MENU/YN REJECT/<u>SELECT SHELF HEIGHT FOR LIFT DISTANCE</u>

ACTION: Select element from the screen which will represent the shelf onto which the object will be lifted

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 22.)

PROMPT 18: SEL MENU/YN REJECT/<u>KEY IN VERTICAL DISTANCE FOR LIFT</u>

ACTION: Key in value which represents the shelf height onto which the object will be lifted **<CR>**

RESULT: Prompt to key in horizontal distance for Lift appears.

PROMPT 19: SEL MENU/YN REJECT/<u>KEY IN HORIZONTAL DISTANCE FOR LIFT</u>

ACTION: Key in value which represents the distance from the man-model to the front edge of the object **<CR>**.

RESULT: Prompt to indicate center of plot for strength table appears. (Go to Prompt 22.)

PROMPT 20: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF HANDLE</u>

ACTION: Select an existing 3-D point to define End Point of handle or key in X,Y,Z coordinates of handle End Point **<CR>**

RESULT: Prompt to define End Point 2 of handle appears.

PROMPT 21: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 22: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 23: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 24: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If lift is successful, man-model along with strength table appears on the drawing performing the lift; CADAM menu appears.

RESULT 2: If lift is unsuccessful because the distance from the man-model to the object is too great, then man-model appears on drawing attempting to perform lift; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the current posture is neither stand, sit, squat, kneeling on one knee, nor kneeling on two knees, then the LIFT Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR SELECTED POSTURE" appears.

RESULT 5: If the line segment selected to define the vertical and horizontal distances is parallel to the plane bisecting the man-model into two halves, then both distances remain undefined, the LIFT Task is abandoned and the message "LINE DEFINING DISTANCES DOES NOT CROSS MAN-MODEL PATH" appears.

RESULT 6: If the user picks a two hand lift with one handle, then the LIFT Task is abandoned and the message "LIFT WITH 1 HANDLE AVAILABLE FOR 1 ARM LIFT ONLY" appears.

RESULT 7: If the selected line defining the distances on the keyed distances for the LIFT task are definitely out of the man-model reach, then the LIFT Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 25: SEL MENU

ACTION: Select **/MENU 1/** to return to the Materials Handling Tasks menu without saving the current man-model

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

9.2.2.4 Push

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***PUSH*** from menu

RESULT: Mobility and Number of Handles Selection menu (Figure 3.28) appears.

PROMPT 4: SELECT MOBILITY TYPE AND NUMBER OF HANDLES YOU WISH TO USE

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Mobility type chosen will be indicated on screen by "YES".

PROMPT 5: SELECT MOBILITY TYPE AND NUMBER OF HANDLES YOU WISH TO USE

ACTION: Select number of handles to be used

RESULT: Number of Handles chosen will be indicated on screen by "YES".

PROMPT 6: SEL VARIABLE/KEY PARM/SEL MENU/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when arm, mobility and handle type selections are complete

RESULT: Drawing reappears and menu to select mode for object dimensions appears.

PROMPT 7: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in object height appears. (Go to Prompt 12.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select object height appears.

PROMPT 8: SEL MENU/YN REJECT/SELECT ELEMENT TO DEFINE OBJECT HEIGHT

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 9: SEL MENU/YN REJECT/SELECT ELEMENT TO DEFINE OBJECT WIDTH

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 10: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT DEPTH</u>

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 11: SEL MENU/YN REJECT/<u>SELECT OTHER ELEMENTS FOR OBJECT SURFACE</u>

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT 1: Prompt to key in coefficient of friction appears (Result of selecting no handles). (Go to Prompt 25.)

RESULT 2: Prompt to define first endpoint of a handle appears (Result of selecting of *one handle*). (Go to Prompt 19.)

RESULT 3: Prompt to define first endpoint of right handle appears (Result of selecting two handles). (Go to Prompt 21.)

PROMPT 12: SEL MENU/YN REJECT/<u>KEY IN OBJECT HEIGHT</u>

ACTION: Key in value representing height of object **<CR>**

RESULT: Prompt to key in object width appears.

PROMPT 13: SEL MENU/YN REJECT/<u>KEY IN OBJECT WIDTH</u>

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 14: SEL MENU/YN REJECT/<u>KEY IN OBJECT DEPTH</u>

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu to select mode for defining shelf height appears.

PROMPT 15: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in vertical distance for push appears. (Go to Prompt 17.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select shelf to define push distance appears.

PROMPT 16: SEL MENU/YN REJECT/<u>SELECT SHELF TO DEFINE PUSH DISTANCE</u>

ACTION: Select element from screen which represents the shelf height where the object will be pushed

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 17: SEL MENU/YN REJECT/<u>KEY IN VERTICAL DISTANCE FOR PUSH</u>

ACTION: Key in value which represents the shelf height where the object will be pushed **<CR>**

RESULT: Prompt to key in horizontal distance for push appears.

PROMPT 18: SEL MENU/YN REJECT/<u>KEY IN HORIZONTAL DISTANCE FOR PUSH</u>

ACTION: Key in a value that represents the distance for the push. **<CR>**

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 19: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define End Point 2 of handle appears.

PROMPT 20: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 21: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF RIGHT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of right handle of End Point 1 or key in X,Y,Z coordinates of right handle End Point 1 **<CR>**

RESULT: Prompt to define second End Point of right handle appears.

PROMPT 22: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF RIGHT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to define first End Point of left handle appears.

PROMPT 23: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF LEFT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of left handle of End Point 1 or key in X,Y,Z coordinates of left handle End Point 1 **<CR>**

RESULT: Prompt to define second End Point of left handle appears.

PROMPT 24: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF LEFT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears.

PROMPT 25: SEL MENU/YN REJECT/KEY IN COEFF OF FRICTION OF SHOES/SURFACE

ACTION: Key in value to define coefficient of friction between man-model's shoes and the surface on which he is standing **<CR>**

RESULT: Menu to determine object clearance appears.

PROMPT 26: SEL MENU

ACTION: Select type of object clearance from bottom menu

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 27: SEL MENU/YN REJECT/INDICATE CENTER OF PLOT

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 28: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 29: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If push is successful, the man-model and strength table appear on the drawing performing the push; CADAM menu appears.

RESULT 2: If push is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing attempting to perform push; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the selected posture does not relate to the current strength data, the push task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR SELECTED POSTURE" appears. Presently only the stand and sit postures have strength data.

RESULT 5: If a line segment chosen for defining the push distance runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; consequently the push distance remains undefined and the "LINE DEFINING DISTANCES DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is less than 0.00001, then the coefficient of friction remains undefined and the message "INVALID COEFFICIENT OF FRICTION -- < 0.00001" appears.

RESULT 7: If the selected handle endpoints are the same, then the PUSH Task is abandoned and the message "INVALID HANDLES -- ENDPOINTS ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is less than one inch, then the PUSH Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR OBJECT DIMENSIONS DEFINED" appears.

RESULT 9: If the user has selected a push distance that is impossible for the man-model to reach, the PUSH Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 30: SEL MENU

ACTION: Select **/MENU 1/** to return to the Materials Handling menu without saving the current man-model

RESULT: Materials Handling menu (Figure 3.22) appears.

9.2.2.5 Pull

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***PULL*** from menu

RESULT: Mobility and Handle Type Selection menu (Figure 3.30) appears.

PROMPT 4: SELECT <u>MOBILITY TYPE</u> AND NUMBER OF HANDLES YOU WISH TO USE

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Mobility type chosen will be indicated on screen by "YES".

PROMPT 5: SELECT MOBILITY TYPE AND <u>NUMBER OF HANDLES</u> YOU WISH TO USE

ACTION: Select handle type to be used

RESULT: Handle type chosen will be indicated on screen by "YES".

PROMPT 6: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when mobility and handle type selections are complete

RESULT: Drawing reappears and menu to select mode for object dimensions appears.

PROMPT 7: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in object height appears. (Go to Prompt 18.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select object height appears.

PROMPT 8: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT HEIGHT</u>

ACTION: Select element in drawing to represent object height

RESULT: Prompt to select object width appears.

PROMPT 9: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT WIDTH</u>

ACTION: Select element in drawing to represent object width

RESULT: Prompt to select object depth appears.

PROMPT 10: SEL MENU/YN REJECT/<u>SELECT ELEMENT TO DEFINE OBJECT DEPTH</u>

ACTION: Select element in drawing to represent object depth

RESULT: Prompt to select any other elements to define object appears.

PROMPT 11: SEL MENU/YN REJECT/<u>SELECT OTHER ELEMENTS FOR OBJECT SURFACE</u>

ACTION: Select other elements in the drawing to define the object; if and when other elements have been defined, select **/END/** from bottom menu

RESULT 1: Prompt to define first endpoint of a handle appears (Result of selecting one handle).

RESULT 2: Prompt to define first endpoint of right handle appears (Result of selecting two handles). (Go to Prompt 14.)

PROMPT 12: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define End Point 2 of handle appears.

PROMPT 13: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 14: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF RIGHT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 **<CR>**

RESULT: Prompt to define second End Point of right handle appears.

PROMPT 15: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF RIGHT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to define first End Point of left handle appears.

PROMPT 16: SEL MENU/YN REJECT/<u>DEFINE END POINT 1 OF LEFT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 1 or key in X,Y,Z coordinates of handle End Point 1 <CR>

RESULT: Prompt to define second End Point of left handle appears.

PROMPT 17: SEL MENU/YN REJECT/<u>DEFINE END POINT 2 OF LEFT HANDLE</u>

ACTION: Select an existing 3-D point to define coordinates of handle of End Point 2 or key in X,Y,Z coordinates of handle End Point 2 **<CR>**

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 18: SEL MENU/YN REJECT/<u>KEY IN OBJECT HEIGHT</u>

ACTION: Key in value which represents the height of the object **<CR>**

RESULT: Menu to select mode for object dimensions appears.

PROMPT 19: SEL MENU/YN REJECT/<u>KEY IN OBJECT WIDTH</u>

ACTION: Key in value representing width of object **<CR>**

RESULT: Prompt to key in object depth appears.

PROMPT 20: SEL MENU/YN REJECT/<u>KEY IN OBJECT DEPTH</u>

ACTION: Key in value representing depth of object **<CR>**

RESULT: Menu to select mode to define shelf height appears.

PROMPT 21: SEL MENU

ACTION 1: Choose **/KEY IN/** from bottom menu

RESULT: Prompt to key in vertical distance for pull appears. (Go to Prompt 23.)

ACTION 2: Choose **/FROM SCREEN/** from bottom menu

RESULT: Prompt to select shelf to define pull distance appears

PROMPT 22: SEL MENU/YN REJECT/<u>SELECT SHELF TO DEFINE PULL DISTANCE</u>

ACTION: Select element from screen which represents the shelf height where the object will be pulled

RESULT: Prompt to key in coefficient of friction appears. (Go to Prompt 25.)

PROMPT 23: SEL MENU/YN REJECT/<u>KEY IN VERTICAL DISTANCE FOR PULL</u>

ACTION: Key in value which represents the shelf height where the object will be pulled **<CR>**

RESULT: Prompt to key in horizontal distance for pull appears.

PROMPT 24: SEL MENU/YN REJECT/<u>KEY IN HORIZONTAL DISTANCE FOR PULL</u>

ACTION: Key in a value that represents the distance for the pull. **<CR>**

RESULT: Prompt to key in coefficient of friction appears.

PROMPT 25: SEL MENU/YN REJECT/<u>KEY IN COEFF OF FRICTION OF SHOES/SURFACE</u>

ACTION: Key in value to define coefficient of friction between man-model's shoes and the surface on which he is standing **<CR>**

RESULT: Menu to determine object clearance appears.

PROMPT 26: SEL MENU

ACTION: Select type of object clearance from bottom menu

RESULT: Prompt to indicate center of plot for strength table appears.

PROMPT 27: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 28: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 29: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If pull is successful, the man-model and strength table appear on the drawing performing the pull; CADAM menu appears.

RESULT 2: If pull is unsuccessful because the distance from the man-model to the object is too great, then the man-model appears on drawing attempting to perform pull; missed distance appears on screen; CADAM menu appears.

RESULT 3: If pull is unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If the selected posture does not relate to the current strength data, the PULL Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR SELECTED POSTURE" appears. Presently only the stand and sit postures have strength data.

RESULT 5: If a line segment chosen for defining the pull distance runs parallel to the plane bisecting the man-model into right and left halves, then no intersection can be found; consequently the pull distance remains undefined and the "LINE DEFINING DISTANCES DOES NOT CROSS THE MAN-MODEL PATH" appears.

RESULT 6: If the coefficient of friction entered is less than 0.00001, then the coefficient of friction remains undefined and the message "INVALID COEFFICIENT OF FRICTION -- < 0.00001" appears.

RESULT 7: If the selected handle endpoints are the same, then the PULL Task is abandoned and the message "INVALID HANDLES -- ENDPOINTS ARE THE SAME" appears.

RESULT 8: If any one of the object dimensions input is less than one inch, then the PULL Task is abandoned and the message "NO STRENGTH DATA AVAILABLE FOR OBJECT DIMENSIONS DEFINED" appears.

RESULT 9: If the user has selected a push distance that is impossible for the man-model to reach, the PULL Task is abandoned and the message "SELECTED LINE DEFINES DISTANCES TOO LARGE FOR REACH" appears.

PROMPT 30: SEL MENU

ACTION: Select **/MENU 1/** to return to the Materials Handling menu without saving the current man-model

RESULT: Materials Handling menu (Figure 3.22) appears.

9.2.2.6 Turn

(Not available at this time.)

9.2.2.7 Grasp

(Not available at this time.)

9.2.2.8 Reach

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***@MMH*** from menu

RESULT: Materials Handling Tasks menu (Figure 3.22) appears.

PROMPT 3: SELECT THE NAME OF THE TASK YOU WISH TO PERFORM

ACTION: Select ***REACH*** from menu

RESULT: Arm and Mobility Type Selection menu (Figure 3.33) appears.

PROMPT 4: SELECT ARM TYPE AND MOBILITY TYPE YOU WISH TO USE

ACTION: Select which arm will perform the reach

RESULT: Arm(s) chosen will be indicated on screen by "YES".

PROMPT 5: SELECT ARM TYPE AND MOBILITY TYPE YOU WISH TO USE

ACTION: Select one of the mobility types to be used during the Reach analysis

RESULT: Mobility type chosen will be indicated on screen by "YES".

PROMPT 6: SEL VARIABLE / KEY PARM / SEL MENU/ YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when arm and mobility type selections are complete

RESULT 1: Drawing reappears and prompt to define Reach Point appears (Result of selecting Right or Left Hand).

RESULT 2: Drawing reappears and prompt to define Reach Point for Right Hand appears (Result of selecting Both Hands). (Go to Prompt 8.)

PROMPT 7: SEL MENU/YN REJECT/DEFINE REACH POINT

ACTION: Select an existing 3-D point from the screen to define Reach Point or key in the X,Y,Z coordinates of Reach Point **<CR>**

RESULT: Grip Type Selection menu appears. (Go to Prompt 10.)

PROMPT 8: SEL MENU/YN REJECT/<u>DEFINE REACH POINT FOR RIGHT ARM REACH</u>

ACTION: Select an existing 3-D point from the screen to define Reach Point for Right Arm or key in the X,Y,Z coordinates of Right Arm Reach Point **<CR>**

RESULT: Prompt to define Left Arm Reach Point appears.

PROMPT 9: SEL MENU/YN REJECT/<u>DEFINE REACH POINT FOR LEFT ARM REACH</u>

ACTION: Select an existing 3-D point from the screen to define Reach Point for Left Arm or key in the X,Y,Z coordinates of Left Arm Reach Point **<CR>**

RESULT: Menu to define Grip Types appears.

PROMPT 10: SEL MENU

ACTION: Select grip type from bottom menu

RESULT: Obstacle avoidance menu appears.

PROMPT 11: SEL MENU

ACTION: Select one of the obstacle avoidance choices from bottom menu

RESULT: Display type menu appears.

PROMPT 12: SEL MENU

ACTION: Select display type from bottom menu (See Table 2.1)

RESULT: CADAM menu appears.

PROMPT 13: SEL MENU

ACTION: Select ***/EXECUTE/*** from bottom menu

RESULT 1: If reach is successful, man-model appears on drawing performing Reach; CADAM menu appears.

RESULT 2: If reach is unsuccessful because the distance from the man-model to the reach point is too great, the man-model appears on the drawing attempting to perform the reach; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

RESULT 4: If a two hand reach was chosen and both reach points are the same, then the REACH Task is abandoned and the message "--**ERROR** CANNOT REACH WITH 2 HANDS TO ONE POINT" appears.

PROMPT 14: SEL MENU

ACTION: Select **/MENU 1/** to return to the Materials Handling menu without saving the current man-model

RESULT: Materials Handling menu (Figure 3.22) appears.

9.2.3 Connector Analysis Function (CONNEC)

PROMPT 1: SELECT THE ABBREVIATION OF THE FUNCTION YOU WISH TO USE

ACTION: Select ***@TSKAN*** from menu

RESULT: CREW CHIEF Task Analyses Function menu (Figure 3.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS YOU WISH TO USE

ACTION: Select ***CONNECTOR*** from the menu

RESULT: Grip Type and Connector Size menu (Figure 3.35) appears.

PROMPT 3: SELECT LABEL NAME WHICH CORRESPONDS TO THE GRIP TYPE AND CONNECTOR SIZE YOU WISH TO USE

ACTION: Select the grip type to be used

RESULT: Grip chosen will be indicated on screen by "YES".

PROMPT 4: **SELECT LABEL NAME WHICH** CORRESPONDS TO THE GRIP TYPE **AND** CONNECTOR SIZE YOU WISH TO USE

ACTION: Select the connector size to be used

RESULT: Connector size chosen will be indicated on screen by "YES".

PROMPT 5: SEL VARIABLE/KEY PARM/SEL MENU/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu after grip type and connector size selections are complete

RESULT: Prompt to define head point of attachment appears.

PROMPT 6: SEL MENU/YN REJECT/DEFINE HEAD POINT OF ATTACH

ACTION: Select an existing 3-D point which defines the point at which the man-model grips the connector or key in X,Y,Z coordinates to define the point at which the man-model grips the connector **<CR>**

RESULT: Prompt to define tail point of attachment appears.

PROMPT 7: SEL MENU/YN REJECT/DEFINE TAIL POINT OF ATTACH

ACTION: Select an existing 3-D point which defines the direction at which the man-model will reach the connector or key in X,Y,Z coordinates to define the direction at which the man-model will reach the connector **<CR>**

RESULT: Hand Selection menu appears.

PROMPT 8: SEL MENU

ACTION: Select from bottom menu which arm will reach for the connector

RESULT: Mobility Type Selection menu appears.

PROMPT 9: SEL MENU

ACTION: Select from bottom menu one of the mobility types to use during the Reach analysis

RESULT: Prompt to define Center of Strength table appears.

PROMPT 10: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a 2-D point in the drawing to position the center of the strength table

RESULT: Menu for obstacle avoidance appears.

PROMPT 11: SEL MENU

ACTION: Select one of the obstacle avoidance choices from the bottom menu

RESULT: Display Type menu appears.

PROMPT 12: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT: CADAM menu appears.

PROMPT 13: YN SAME/<u>SEL MENU</u>/

ACTION: Select **/EXECUTE/** from bottom menu

RESULT 1: If task is successful, the man-model and strength table appear on the drawing performing a task; CADAM menu appears.

RESULT 2: If task is unsuccessful because the distance from the man-model to the connector is too great, the man-model appears on drawing attempting to perform task; missed distance appears on screen; CADAM menu appears.

RESULT 3: If unsuccessful due to interference, arrows are displayed indicating points of interference; CADAM menu appears.

PROMPT 14: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving the current man-model

RESULT: Task Analysis menu (Figure 3.1) appears.

9.3 VISIBILITY ANALYSIS FUNCTION (VISAN)

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***VISAN*** from menu

RESULT: Menu to select viewpoint as seen by man-model or as user-defined arbitrary point.

PROMPT 2: SEL MENU

ACTION 1: Select **/VIEWPOINT - CREWCHIEF'S/** from bottom menu

RESULT: Menu to include or exclude man-model appears.

ACTION 2: Select **/USER DEFINED/** from bottom menu

RESULT: Prompt to define eye location point appears. (Go to Prompt 4.)

PROMPT 3: SEL MENU

ACTION: Select from bottom menu whether to include or exclude the man-model during visual analysis

RESULT: Prompt to define center of visibility plot appears. (Go to Prompt 6.)

PROMPT 4: SEL MENU/YN REJECT/<u>DEFINE EYE LOCATION POINT</u>

ACTION: Select an existing 3-D point to define the eye location or key in the X,Y,Z coordinates to define the eye location point **<CR>**

RESULT: Prompt to define eye target point appears.

PROMPT 5: SEL MENU/YN REJECT/<u>DEFINE EYE TARGET POINT</u>

ACTION: Select an existing 3-D point to define the eye target point or key in the X,Y,Z coordinates to define the eye target point **<CR>**

RESULT: Prompt to define center of visibility plot appears.

PROMPT 6: SEL MENU/YN REJECT/INDICATE CENTER OF PLOT

ACTION: Indicate a 2-D point to determine where the center of visibility plot will appear on screen

RESULT: Plot appears on screen as specified by center of plot location.

PROMPT 7: SEL MENU

ACTION: Select **/MENU 1/** to continue any analysis without saving current man-model

RESULT: CREW CHIEF Main Programs menu (Figure 1.3) appears.

9.4 ACCESSIBILITY ANALYSES FUNCTION (@ACCES)

9.4.1 CREW CHIEF Interference Analysis Function (INTFER)

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@ACCES*** from menu

RESULT: CREW CHIEF Accessibility Functions menu (Figure 5.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***INTFER*** from menu

RESULT: Level of Interference Checking menu (Figure 5.2) appears.

PROMPT 3: SELECT THE LEVEL OF INTERFERENCE CHECKING YOU WISH TO USE

ACTION: Select the level of interference to be used in the analysis

RESULT: Level of interference chosen will be indicated on screen by "YES".

PROMPT 4: SEL VARIABLE/KEY PARM/<u>SEL MENU</u>/YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu after level of interference selection is complete

RESULT: Display type menu appears.

PROMPT 5: SEL MENU

ACTION: Select a display type (see Table 2.1) from bottom menu

RESULT: Man-model appears superimposed on drawing and, if interference found, 3-D arrows indicating points of interference between the man-model and elements in the drawing are displayed.

PROMPT 6: SEL MENU

ACTION: Select **/MENU 1/** to return to the CREW CHIEF Accessbility Functions menu (Figure 5.1) without saving the current man-model

RESULT: Program returns to the CREW CHIEF Accessibility Functions menu (Figure 5.1).

9.4.2 <u>Work Envelope Analysis Function (WRKENV)</u>

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***@ACCES*** from menu

RESULT: CREW CHIEF Accessibility Functions menu (Figure 5.1) appears.

PROMPT 2: SELECT THE ABBREVIATION UNDER THE ANALYSIS FUNCTION YOU WISH TO USE

ACTION: Select ***WRKENV*** from menu

RESULT: Types of Work Envelope menu (Figure 5.4) appears.

PROMPT 3: SELECT THE TYPE OF ENVELOPE, AND IF NECESSARY, KEY IN THE REACH INCREMENT YOU WISH TO USE

ACTION: Select the type of envelope to be used in the analysis (see Figure 5.4)

RESULT 1: Envelope type chosen will be indicated on screen by "YES". (If SWEPT VOLUME or TOOL ENVELOPE is selected, go to PROMPT 5.)

RESULT 2: Envelope type chosen will be indicated on screen by "YES".

PROMPT 4: SELECT THE TYPE OF ENVELOPE, AND IF NECESSARY, KEY IN THE REACH INCREMENT YOU WISH TO USE

ACTION: Key in the reach increment **<CR>** or accept the default value

RESULT: Value keyed in appears in center of screen.

PROMPT 5: SEL VARIABLE / KEY IN PARM / SEL MENU / YN NEXT

ACTION: Select **/EXECUTE/** from bottom menu when envelope type and/or reach increment selections are complete

RESULT 1: Display Type menu appears (result of selecting SWEPT VOLUME or TOOL ENVELOPE types). (Go to Prompt 7.)

RESULT 2: Mobility Type menu appears.

PROMPT 6: SEL MENU

ACTION: Select one of the mobility types from bottom menu.

RESULT: Display Type menu appears.

PROMPT 7: SEL MENU

ACTION: Select one of the display types (Table 2.1) from bottom menu

RESULT 1: If SWEPT VOLUME was selected, the tool appears in the drawing attached as it was in the previous tool analysis. The full sweep of the tool handle is displayed on the screen.

RESULT 2: If TOOL ENVELOPE was selected, the tool appears in the drawing attached as it was in the previous tool analysis. The sweep of the tool handle, as obstacles will allow, is displayed on the screen.

RESULT 3: If WORK ENVELOPE was selected, the man-model appears in the drawing with the tool attached as it was in the previous tool analysis. The sweep of the tool handle, as reach and obstacles will allow, is displayed on the screen.

RESULT 4: If a tool Analysis has not been previously executed (no tool in either hand), the message "NO TOOL SELECTED FOR EITHER HAND" appears.

RESULT 5: If an invalid tool number is input for either hand, the message "INVALID TOOL NUMBER" appears.

RESULT 6: If a tool(s) has an envelope that is undefined, the message "TOOL SELECTED HAS UNDEFINED ENVELOPE" appears.

RESULT 7: If a tool(s) has an envelope that does not have an envelope, the message "TOOL SELECTED DOES NOT HAVE AN ENVELOPE" appears.

RESULT 8: If an unsuccessful reach occured during the Tool analysis, the message "UNSUCCESSFUL REACH" appears.

RESULT 9: If obstacle avoidance was not performed during the Tool Analysis, the message "OBSTACLE AVOIDANCE FLAG NOT SET" appears.

RESULT 10: In the previous Tool Analysis, if an unsuccessful reach occured and the obstacle avoidance flag was not turned on, the message "UNSUCCESSFUL REACH - OBSTACLE AVOIDANCE FLAG NO SET" appears.

PROMPT 8: SEL MENU

ACTION: Select **/MENU 1/** to return to the Accessibility Analysis menu without saving the current man-model

RESULT: Accessibility Analysis menu (Figure 5.1) appears.

9.5 DISPLAY CURRENT CREW CHIEF DATA FUNCTION (CONFIG)

PROMPT 1: SELECT THE ABBREVIATION UNDER THE FUNCTION YOU WISH TO USE

ACTION: Select ***CONFIG*** from menu

RESULT: Prompt to indicate center of plot for CREW CHIEF data sheet appears.

PROMPT 2: SEL MENU/YN REJECT/<u>INDICATE CENTER OF PLOT</u>

ACTION: Indicate a point on the screen to determine where the center of the CREW CHIEF data sheet will appear

RESULT: The current CREW CHIEF data sheet appears on the screen.

PROMPT 3: SEL MENU

ACTION: Select **/MENU 1/** to return to the CREW CHIEF Main Programs menu (Figure 1.3) without saving the data sheet

RESULT: Program returns to the CREW CHIEF Main Programs menu (Figure 1.3).

REFERENCES

1. CADAM Geometry Interface Installation Guide, #C-200-050-I, Burbank, CA: CADAM, Inc., 1 Dec 1984.

2. CADAM Interactive User Reference Manual (Vol. 2), #C-200-020-URM, Burbank, CA: CADAM, Inc., 1 Dec 1984.

3. Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

4. Ayoub, M.M., Denardo, J.D., Smith, J.L., Bethea, N.J., Lambert, B.K., Alley, L.R., & Duran, B.S., Establishing Physical Criteria for Assigning Personnel to Air Force Jobs, Lubbock, TX: Institute for Ergonomic Research, Texas Tech University, Sept 1982.

5. CADAM Geometry Interface, User Reference Manual, #C-200-050-5, Burbank, CA: CADAM, Inc., 16 Aug 1984.

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS AND CAPABILITIES OF THE MAN-MODEL

APPENDIX A

GENERATION OF THE PHYSICAL CHARACTERISTICS AND CAPABILITIES OF THE MAN-MODEL

The primary purpose of the CREW CHIEF system of programs is to improve maintainability during the design process by assessing the interactions of the physical characteristics and capabilities of the maintenance technician and the work station. MIL-STD-1472C, "Human Engineering Design Criteria for Military Systems, Equipment and Facilities," (Reference A.1), and changes thereto, establishes general human engineering criteria for military systems, subsystems, equipment, and facilities.

Paragraph 5.6.1 states: "Generally, design limits shall be based upon a range from the 5th percentile female to the 95th percentile male values for critical body dimensions, as appropriate. For any body dimension, the 5th percentile value indicates that five percent of the population will be equal to or smaller than that value, and 95 percent will be larger; conversely, the 95th percent value indicates that 95 percent of the population will be equal to or smaller than that value, and five percent will be larger. Therefore, use of a design range from the 5th to 95th percentile will theoretically provide coverage for 90 percent of the user population for that value."

Paragraph 5.6.3.2 states: "Clearance dimensions (e.g., for passageways and access), which must accommodate or allow passage of the body, or parts of the body, shall be based upon the 95th percentile values for body dimensions."

Paragraph 5.6.3.3 states: "Limiting dimensions (reaching distance, control movement, displays, test points, handrails, etc.) which restrict, or are limited by, extensions of the body shall be based upon the 5th percentile values for applicable body dimensions."

The CREW CHIEF programs must work within the design criteria stated here. Thus the range of operator sizes must necessarily include, as a minimum, the range of 5th percentile female through 95th percentile male. The program includes the 1st, 5th, 50th, 95th, and 99th percentile body sizes for both male and female; thus there is a range of 1st percentile female through 99th percentile male. Pending changes to Military Standards and Specifications are expected to require this range in some applications. This appendix addresses the body size of the technician model as a function of the skeletal link system, enfleshment, and clothing bulk.

Since maintenance technicians work in a wide range of postures, the joint mobility of the skeletal link system is a vital consideration to the development of the model. Additionally, the effect of body/body segment mass and center of gravity must be considered in establishing joint mobility limits. A maintenance technician must be able to maintain balance while performing a task. Thus, individual joint mobility limits may vary with differing body segment relationships for changes in posture.

The ability of the technician to see the task object is another area of concern. This appendix also addresses the data bases and derivation of the visual analysis function of the programs.

The ability to apply force in a specific manner to a task-related object is another physical capability that is addressed in the CREW CHIEF programs. The development of the strength data bases will also be discussed.

A.1 CREW CHIEF MODEL SKELETAL LINK SYSTEM AND ENFLESHMENT

The model used in the CREW CHIEF system of programs is based on a 35-link skeletal system. These links connect the major points of rotation of body segments and are used to graphically display the model in different postures. The lengths of the links are calculated by regression from 13 readily measured anthropometric variables (e.g., stature, sitting height, weight, etc.).

The 1965 Survey of US Air Force Male Personnel (Reference A.2) was used as the basis for the male calculations. This survey includes 3869 subjects. Officer subjects were discarded, as were those subjects not meeting current weight restrictions of Air Force Regulation (AFR) 160-43. The remaining 2084 subjects were used for the regression equation data pool.

The 1968 Survey of US Air Force Women (Reference A.3) and the 1977 Survey of US Army Women (Reference A.4) were purged of data of subjects not meeting the weight limits of AFR 160-43.

The remaining 3037 subjects from the two surveys were used for the regression equation data pool for females.

The 1981 Study of Weight Lifting Capabilities of Air Force Basic Trainees (Reference A.5) was selected as the best reflection of the current Air Force maintenance technician population. This survey had only two relevant anthropometric measures, stature and weight. The regression equations calculated from the 1965 US Air Force Male Personnel, 1968 US Air Force Women, and 1977 US Army Women surveys were applied to the variables (stature and weight) from the 1981 survey of Air Force Basic Trainees to calculate the remaining 11 anthropometric variables required to generate the 35 internal links and the enfleshment of the CREW CHIEF man-model.

The enfleshment of the CREW CHIEF man-model is based on a modeling technique to define three-dimensional (3-D) coordinates of solid objects. Solid objects, such as hand forms, head forms, and boots, are divided into triangular facets with the vertices and edges of the triangles identified for tracking. A sonic digitizer is used to define the local X, Y, and Z coordinates of the vertices. A series of sorting routines to identify coincidental edges and points; to convert local X,Y,Z coordinates to the CREW CHIEF coordinate system; and to determine the display lines are used to provide the desired graphic presentation.

Ellipses are placed about major joint centers. The ellipses are connected, and the modeling technique for solid objects is used to determine the display lines for the body

enfleshment. Multiple ellipses are placed at the joint centers, e.g., the knees, elbows, and shoulders, which exhibit high compressibility. The body is divided into 13 semi-unique sets of ellipses. These are the lower and upper trunk, head, lower and upper arms (left and right), hands (left and right), and lower and upper legs (left and right), with the lower legs including the feet. These sets are classified as semi-unique in that a main ellipse may be contained in different sets. For example, the lower and upper arm sets each contain the main ellipse at the elbow.

To increment the nude enfleshment radii to portray clothing bulk, subjects were measured both nude and in the four clothing configurations (fatigues, fatigues with jacket, arctic, and chemical defense).

A.2 CREW CHIEF MODEL JOINT MOBILITY

Joint mobility is the movement at the skeletal links which defines and portrays the various postures of the technician model. Posture includes the variations in positioning of body segments, such as arms, legs, and trunk segments, to properly position the technician model in relation to the task object. Two aspects must be considered: first, the limits of motion (joint mobility limits) around an individual joint; and second, the stability (balance) of the technician model when in a specific posture in relation to the task object.

Joint mobility limits are based, at present, upon previous range of motion studies. The mobility limits data are being updated as a result of recent research and will be included in future CREW CHIEF releases. Future mobility limits will also address out-of-balance conditions.

A.3 CREW CHIEF MODEL VISUAL ANALYSIS

The techniques for displaying the field-of-view of the technician model are relatively simple and already exist. Existing vision data bases are primarily concerned with peripheral vision. A maintenance technician man-model must be concerned with visual acuity rather than with peripheral vision. Data bases for visual acuity (field-of-focus) must be generated. Planning to collect the data for these data bases is in progress.

A.4 CREW CHIEF MODEL STRENGTH CAPABILITIES

The strength capabilities of the CREW CHIEF man-model are divided into two areas.

(1) Torque: the ability to apply a force to:

- (a) a tool, primarily a wrench, that results in a torque value that can be applied to a fastener. See Appendix C for those tools which will have torque values in the program.
- (b) an electrical connector, with the hand alone, in a clockwise or counter-clockwise direction.

(2) Materials Handling: related to moving, lifting, carrying, pushing, pulling, positioning, and holding objects.

Strength, in general, is not highly correlated to body size. Thus, in the CREW CHIEF man-model, the percentile values are based on strength capabilities across a population, not on the percentile value of the body size. Strength data bases for CREW CHIEF were created from ergonomics studies specifically designed to simulate aircraft maintenance tasks. Strength data from test subjects were related to the aircraft technician population through a series of strength tests that had been previously administered to Air Force personnel. Since there are few restrictions on the assignment of Air Force personnel to maintenance AFSCs, these subjects were deemed to be representative of the Air Force maintenance technician population. During the data collection phase of Torque and Materials Handling data bases, subjects performed 1 to 7 of the same strength tests. Regressors from the cited study are used to distribute the predictions from the Torque and Materials Handling data bases across the maintenance population.

A.4.1 TORQUE

Data bases providing the information required to predict the force a maintenance technician can exert on a wrencn, or electrical connector, were not available when CREW CHIEF program development was begun. A series of tests using torque measuring devices was implemented. The basic variables in the wrench torque studies include posture; bolt elevation as a percentage of the finger tip vertical reach for a given posture; distance of the body from the bolt head; wrench handle orientation (selected

position around the 360-degree circle of the bolt axis); bolt orientation (relative to the mid-saggital plane of the body); type wrench (ratchet with socket, open end, box end, etc.); and the reach around and over obstacles to the wrench handle.

Experiments were performed to develop the data bases for the prediction of force that can be applied to an electrical connector. The variables considered in the electrical connector experiments were: connector diameter (three sizes); type of grip (two types); hand covering (bare and two types of glove); direction of torque (clockwise and counter-clockwise); work height (as a percentage of subject's finger tip vertical reach); direction of approach (front, back and side); and distance of connector from other connectors above, below, or to the side of the task connector.

A.4.2 MATERIALS HANDLING

A series of experiments is being conducted to develop the Materials Handling data bases. The lifting phases of the experiments are done in various postures (kneeling, standing, sitting, supine and prone). Lifting tasks are one- or two-handed. Various size boxes are used for the different tasks, and the weight can be adjusted. The subject could request the experimenter to add or remove weight until the subject reached his maximum without straining himself. (The weights were not individually marked, so the subject did not know the weight lifted.)

A common task in system maintenance is to position an object and hold it in place with one hand while securing it with the other hand. Hold/Position studies are based on posture, target height (expressed as a percentage of the subject's fingertip vertical reach for the posture used in the exertion), barriers (used above and in front of the target to simulate working conditions), and the weight of the object (variable from 10 to 110 pounds). The object is positioned with both hands and, once positioned, is held in place with the left hand. The time the object is held within the confines of the target is measured up to a maximum of 60 seconds. Sixty subjects, 30 female and 30 male, participated in the experiment.

Experiments were performed to collect data for Push/Pull capabilities. This study was divided into three phases, with a total of 230 exertions performed by 20 female and 20 male subjects. Subjects were selected on the basis of age (18 to 30 years), body size and weight limits within the limits of AFR 160-43, and their abilities to lift 40 pounds to 6 feet on a weight lift machine (attainment of a Factor-X Score of 3). Variables for the exertions included five postures, two directions (push and pull), handle position (distance above the support platform), foot position (distance from the handle expressed as percentage of vertical reach), and angle of the elbow (straight or bent). Exertions were also performed in two methods (freestyle and controlled). In freestyle, the subject was allowed to push or pull to attain the maximum horizontal force. In controlled, the subject was required to keep the vertical

force less than 10% of the maximum horizontal forces. A sonic digitizer was used to digitize 14 points on the body during each exertion and to relate body angles to force data.

APPENDIX B

CLOTHING ENSEMBLE DESCRIPTIONS

APPENDIX B

CLOTHING ENSEMBLE DESCRIPTIONS

B.1 FATIGUES, WITHOUT JACKET

The fatigues ensemble (see Figure B.1) is the normal work clothing for maintenance technicians and is worn in shops and on the flight line during moderate to hot temperatures. The shirt has long or short sleeves. The shoes are rubber-soled work shoes or flight boots. The fatigue cap is part of the ensemble, but is often removed during maintenance activities.

B.2 FATIGUES, WITH JACKET

This uniform consists of the basic fatigues ensemble with a jacket added. It is used at cooler temperatures on the flight line and in unheated shops (see Figure B.2).

B.3 ARCTIC

The arctic clothing ensemble adds a parka with fur-lined hood, insulated trousers, and mittens to the fatigue ensemble for protection in cold temperatures. The mukluk replaces the work shoes or flight boots. Under wet conditions, the work shoes or flight boots may be worn, because the mukluks are not water-resistant. Due to their inhibition of manual dexterity, the mittens are normally replaced with the work glove while performing maintenance, so they are not included in the graphic display of the technician model. The parka hood over the head

Figure B.1. Photograph Showing Fatigues Ensemble: (a) Side View, and (b) Front View.

Figure B.2. Photograph Showing Fatigue Ensemble With Jacket Added: (a) Side View and (b) Front View.

can restrict the technician's vision. During maintenance activities, if the hood interferes with the technician's vision, it is laid back on the shoulders (see Figure B.3).

B.4 CHEMICAL DEFENSE

The chemical defense ensemble (see Figure B.4) is worn over fatigues and consists of a mask, over-garment, hood, over-boots, and rubber gloves. Both cotton and rubber gloves are worn under the leather work gloves. This ensemble is used when the technician is threatened with hazardous chemical/biological agents.

Figures B.5 through B.8 show the man-model as it appears in each of these clothing ensembles. Default clothing type is fatigues (Figure B.5).

Figure B.3. Photograph of Man Wearing Arctic Clothing Ensemble: (a) Side View, and (b) Front View.

Figure B.1. Photograph of Man Wearing Chemical Defense Ensemble: (a) Right View, (b) Front View, and (c) Left View.

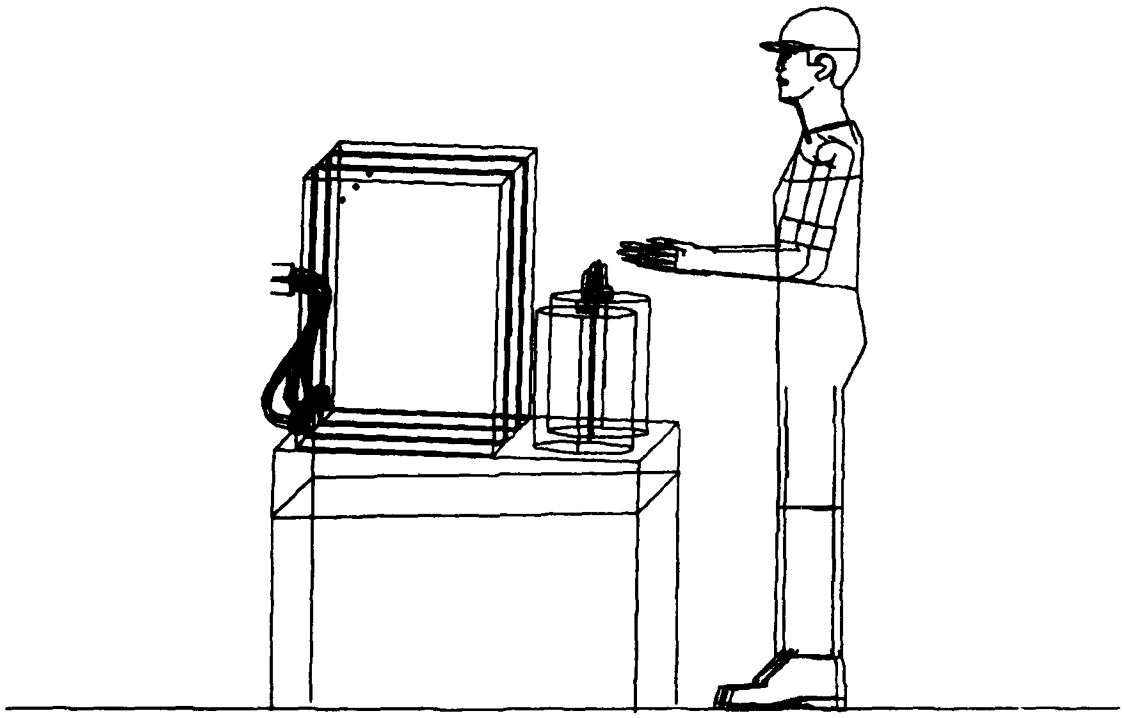


Figure B.5. Fatigues, Without Jacket.

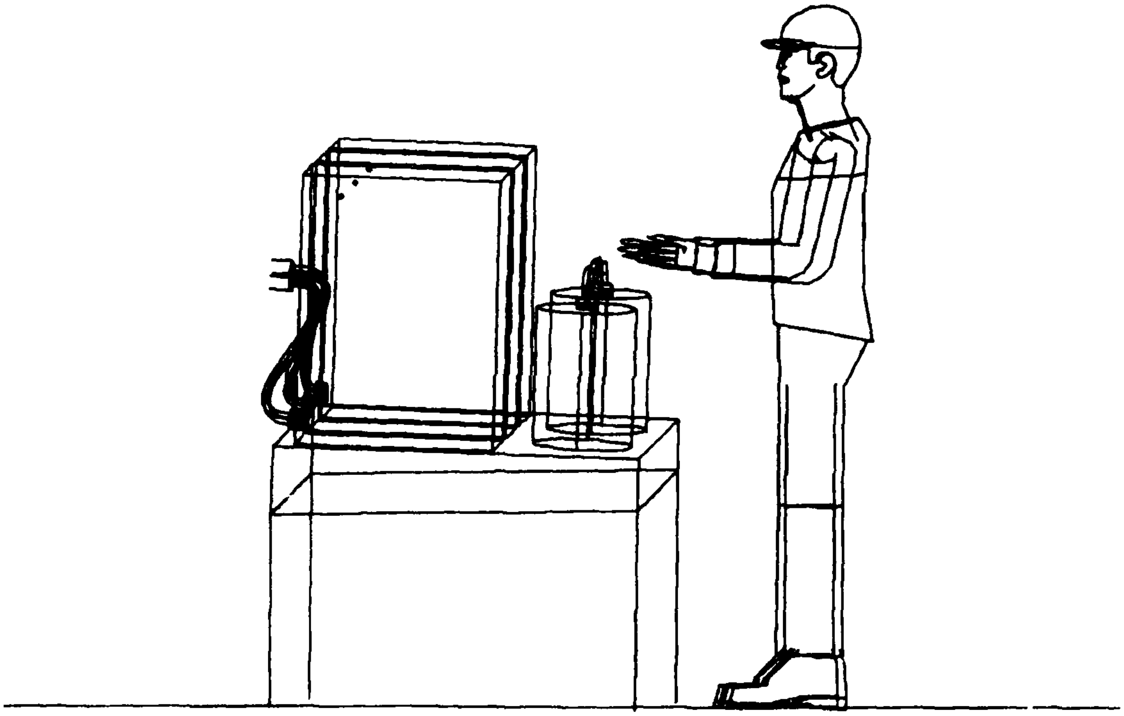


Figure B.6. Fatigues, With Jacket.

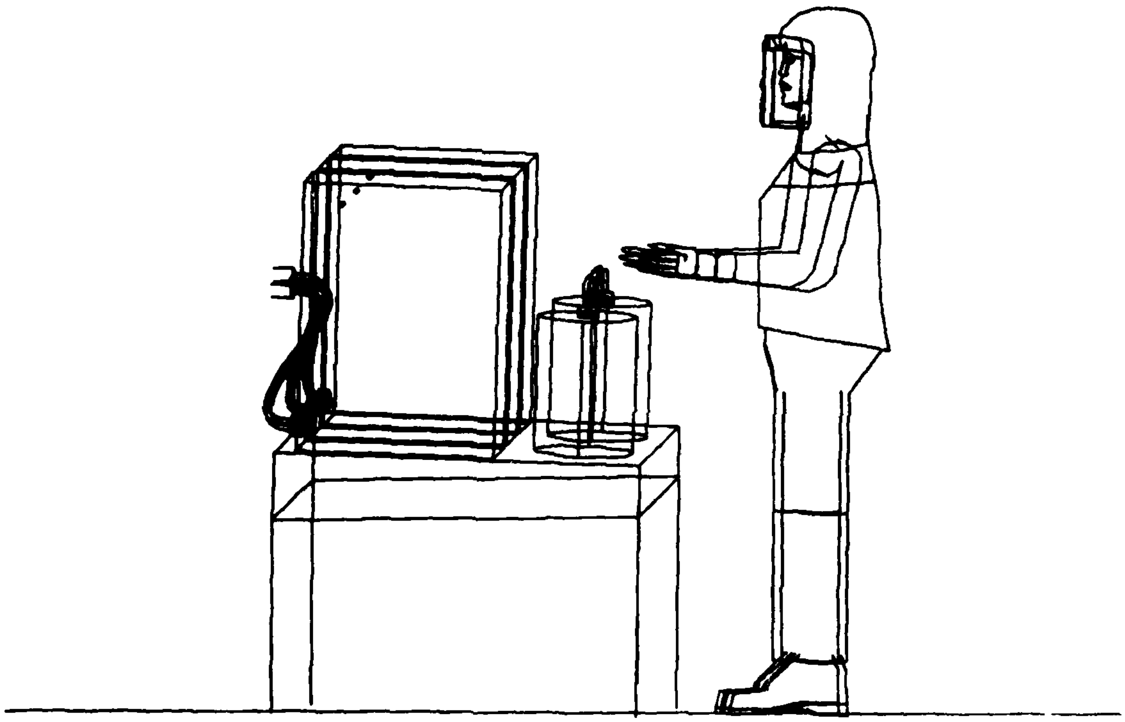


Figure B.7. Arctic Ensemble.

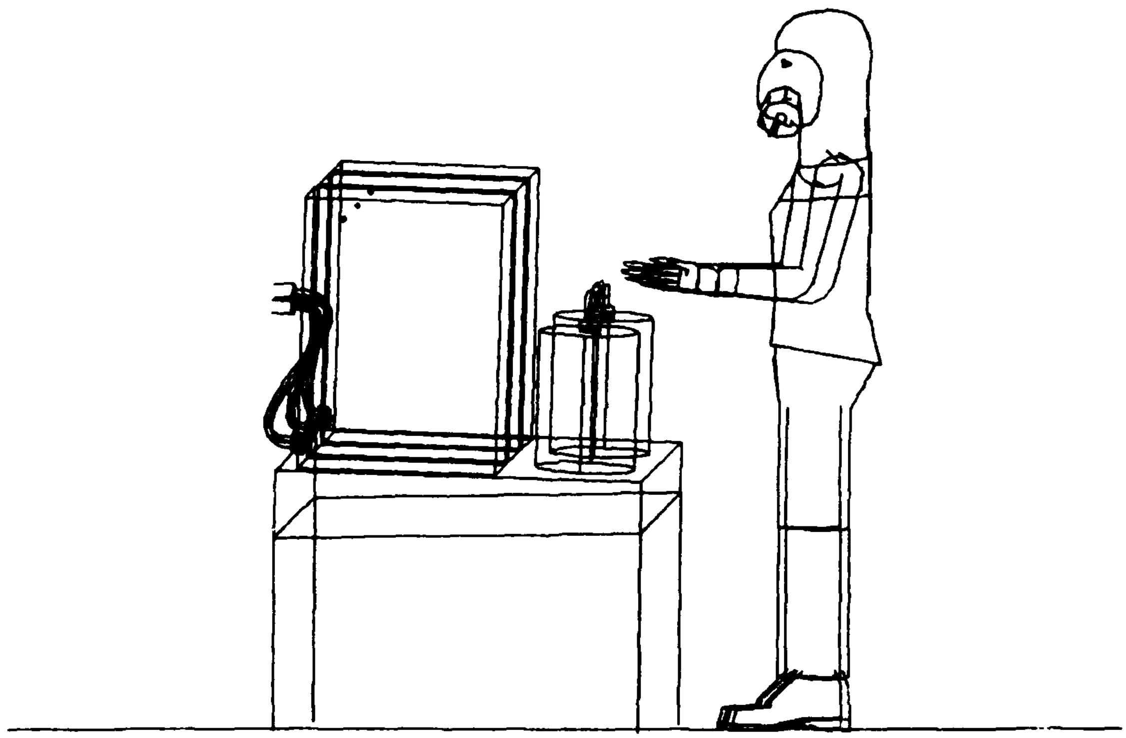


Figure B.8. Chemical Defense Ensemble.

APPENDIX C

BODY POSTURES

APPENDIX C

BODY POSTURES

The twelve postures represent common postures found in a maintenance environment. These postures allow initial generation of the man-model in a posture which closely approximates the one desired. The initial postures can be further modified manually (using the Reposition Function), or automatically by the Task Analysis functions. The twelve postures available in the Initialization Function can be seen in Figures C.1 through C.12. Standing posture is the default.

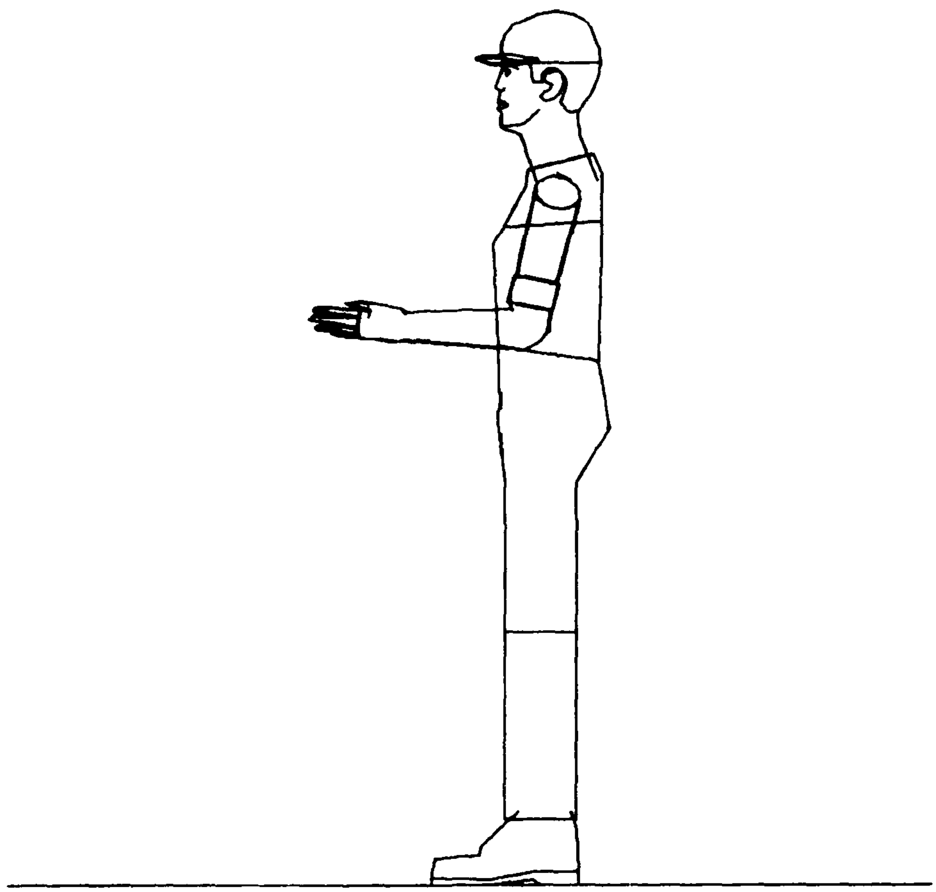


Figure C.1. Initial Stand Posture, with Position Reference Point on Platform and Centered Between the Ankles.

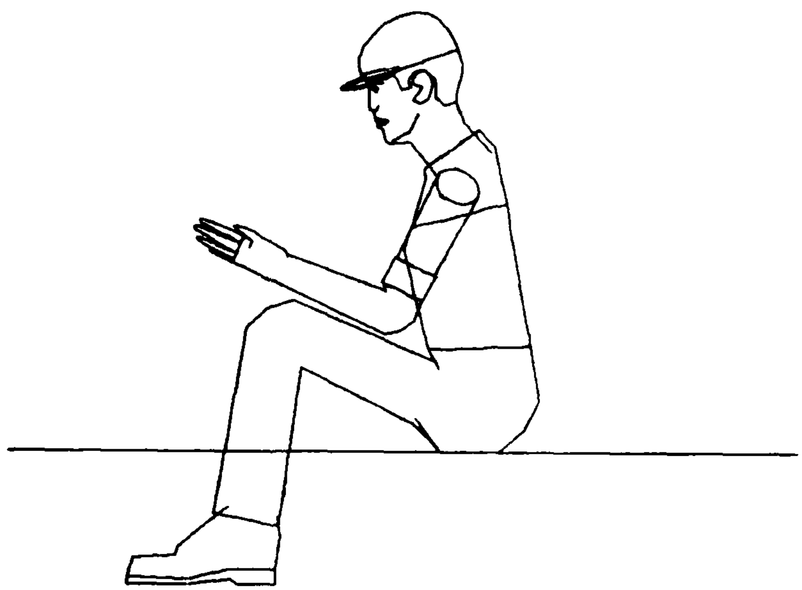


Figure C.2. Initial Sitting Posture, with Position Reference Point at Center of Seat Pan.

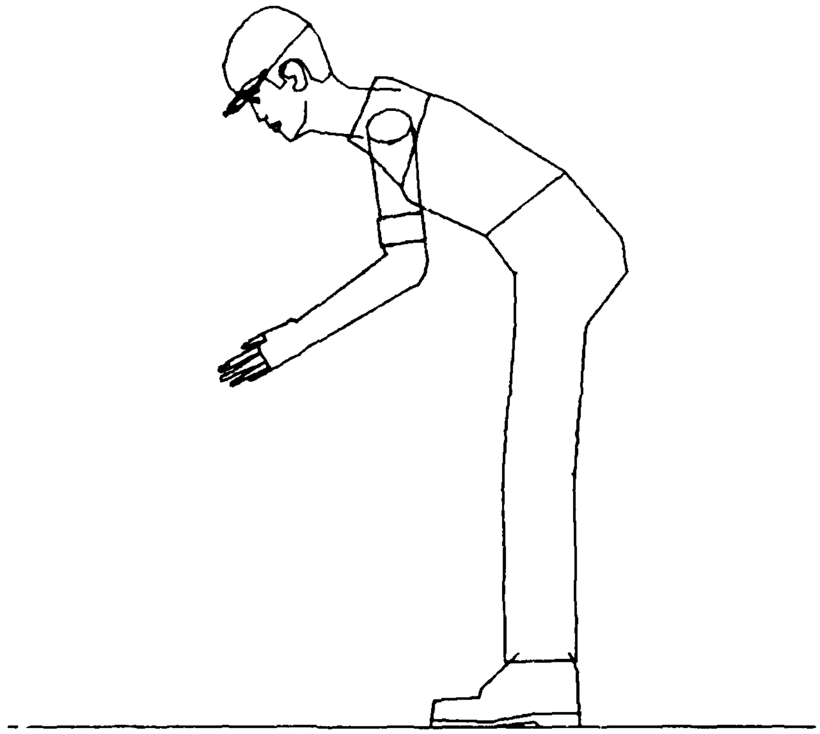


Figure C.3. Initial Bend Posture, with Position Reference Point on Platform and Centered Between the Ankles.

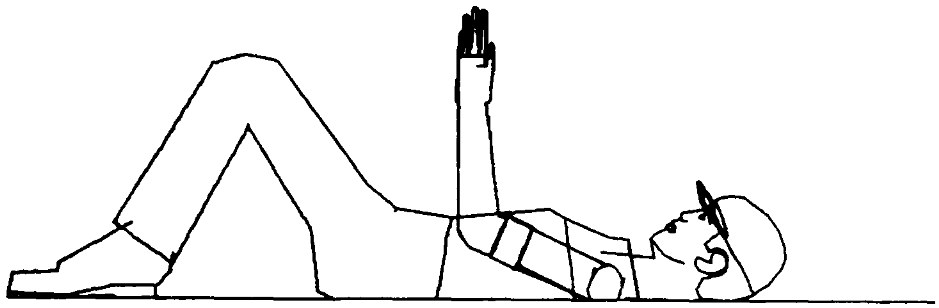


Figure C.4. Initial Supine Posture, with Position Reference Point on Platform and Centered Between Shoulders.

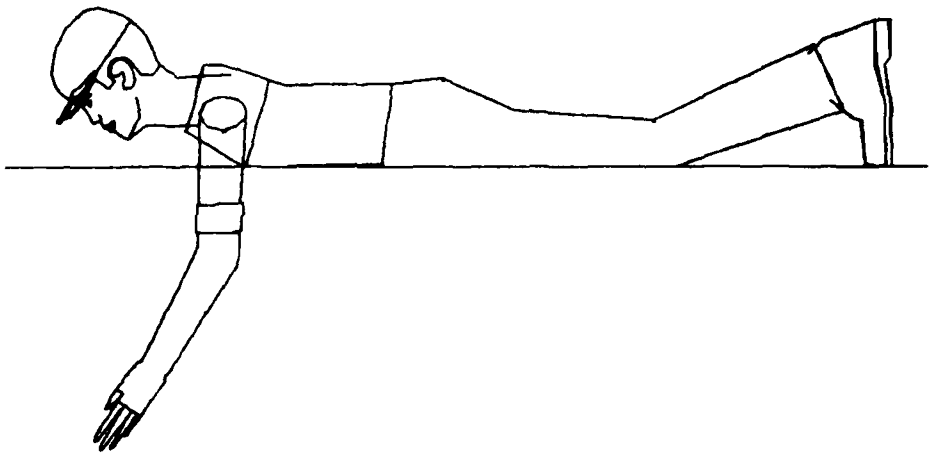


Figure C.5. Initial Prone Posture, with Position Reference Point on Platform and Centered Between Shoulders.

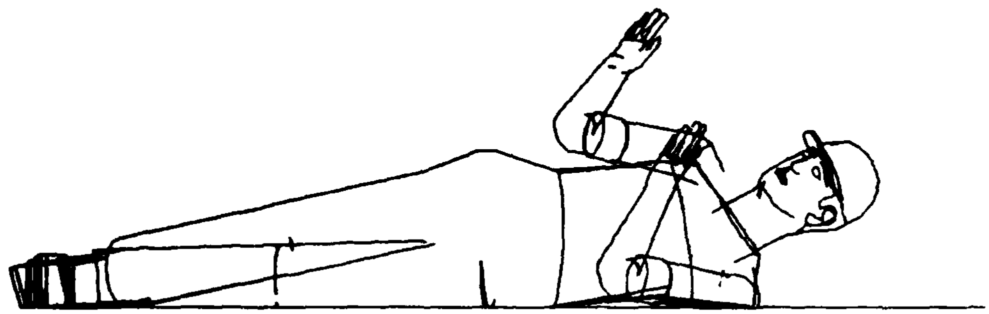


Figure C.6. Initial Side Posture, with Position Reference Point on Platform and Centered Between Shoulders.

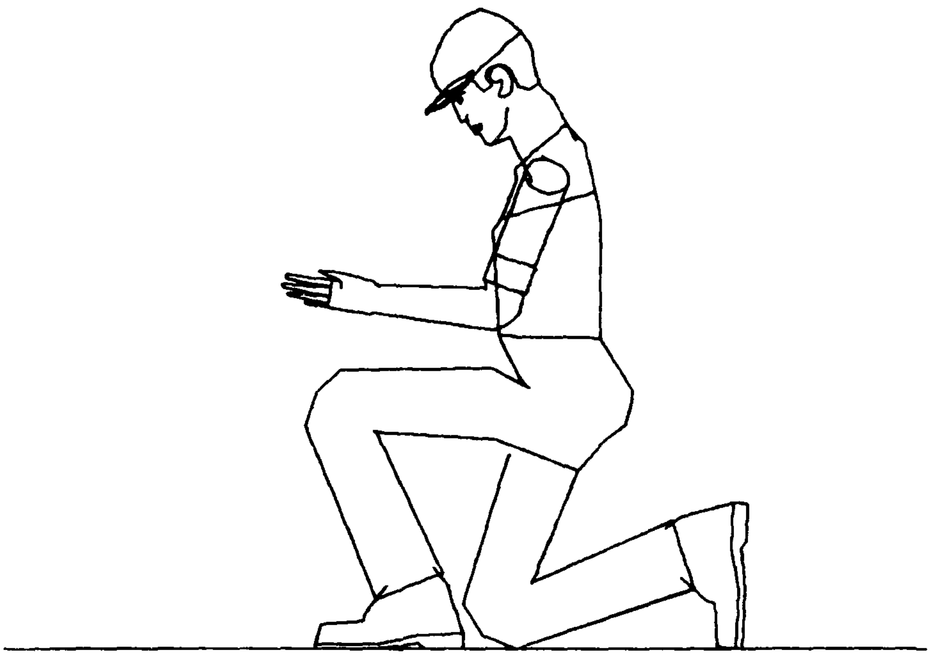


Figure C.7. Initial Kneel Posture, One Knee, with Position Reference Point on Platform and Centered Between Left Knee and Right Foot.

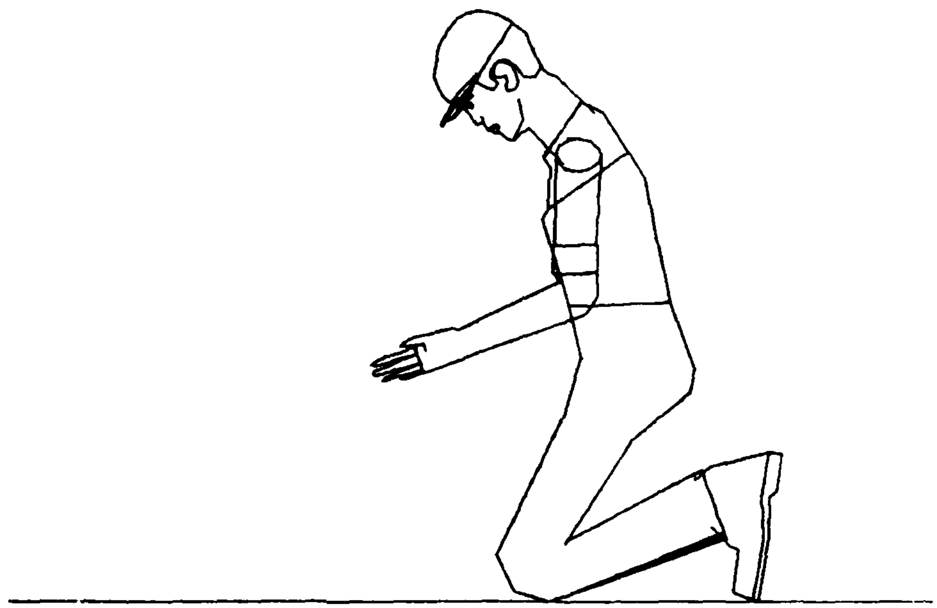


Figure C.8. Initial Kneel Posture, Two Knees, with Position Reference Point on Platform and Centered Between Knees.

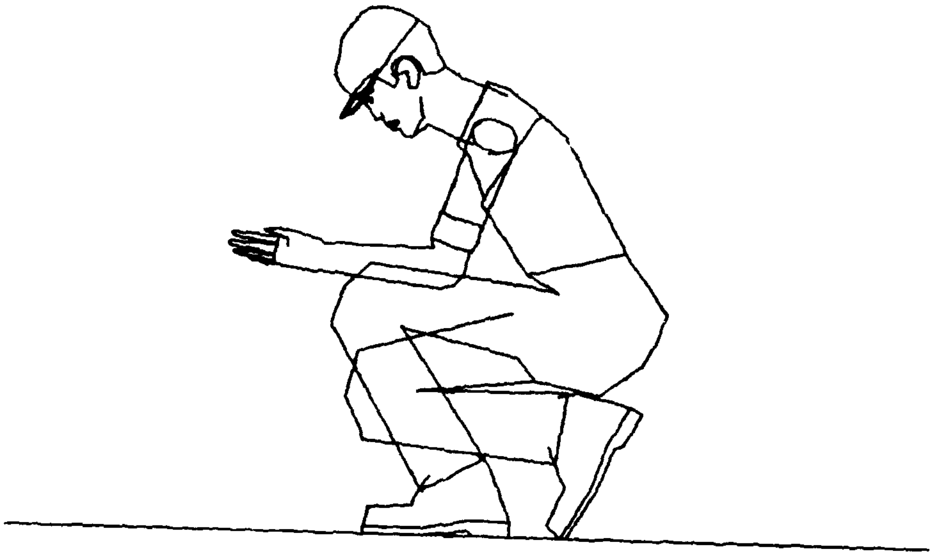


Figure C.9. Initial Squat Posture, with Position Reference Point on Platform and Centered Between the Ankles.

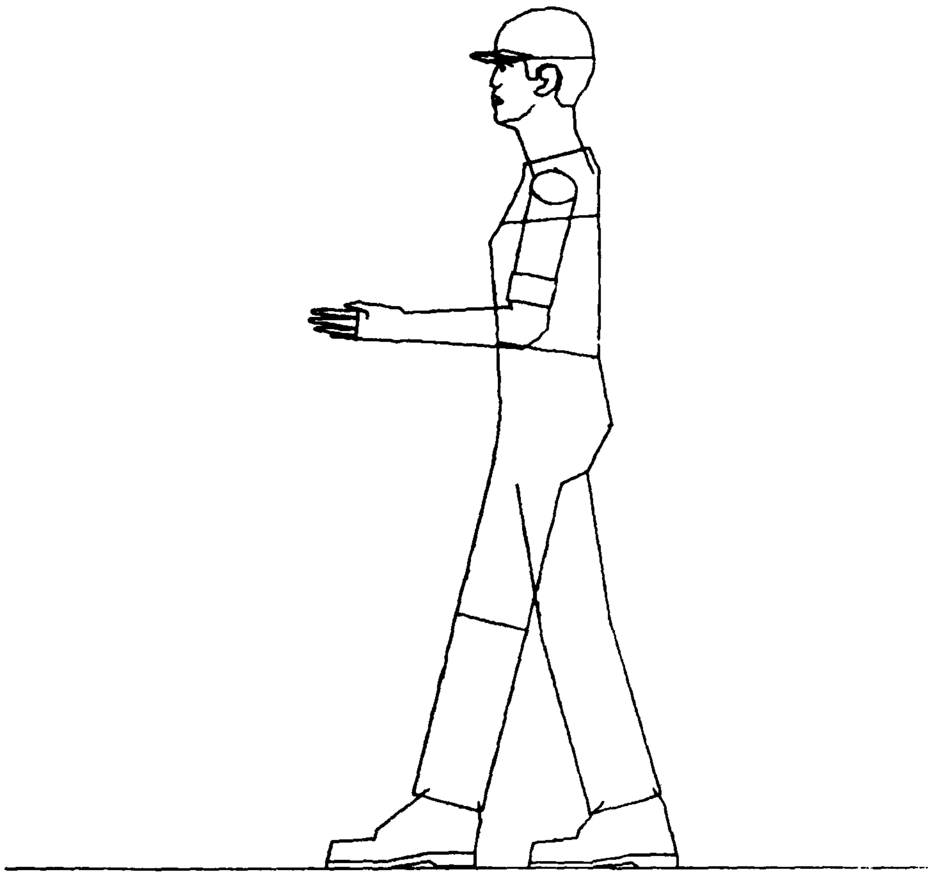


Figure C.10. Initial Walk Posture, with Position Reference Point on Platform and Centered Between the Feet.

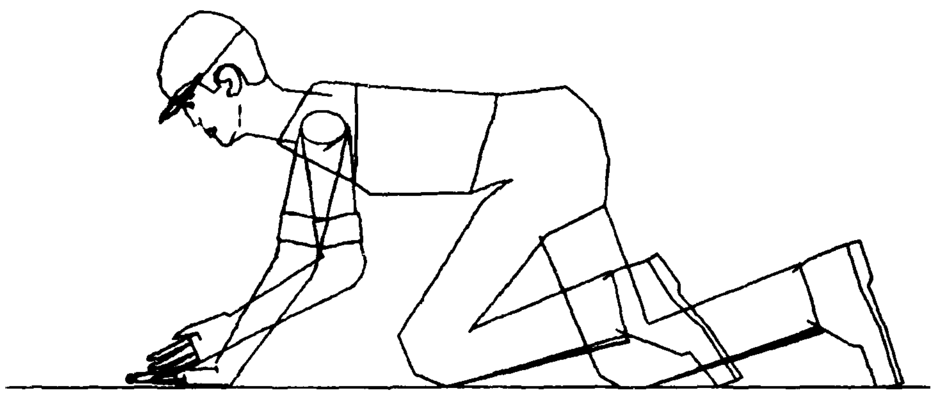


Figure C.11. Initial Crawl Posture, with Position Reference Point on Platform and Centered Between Knees.

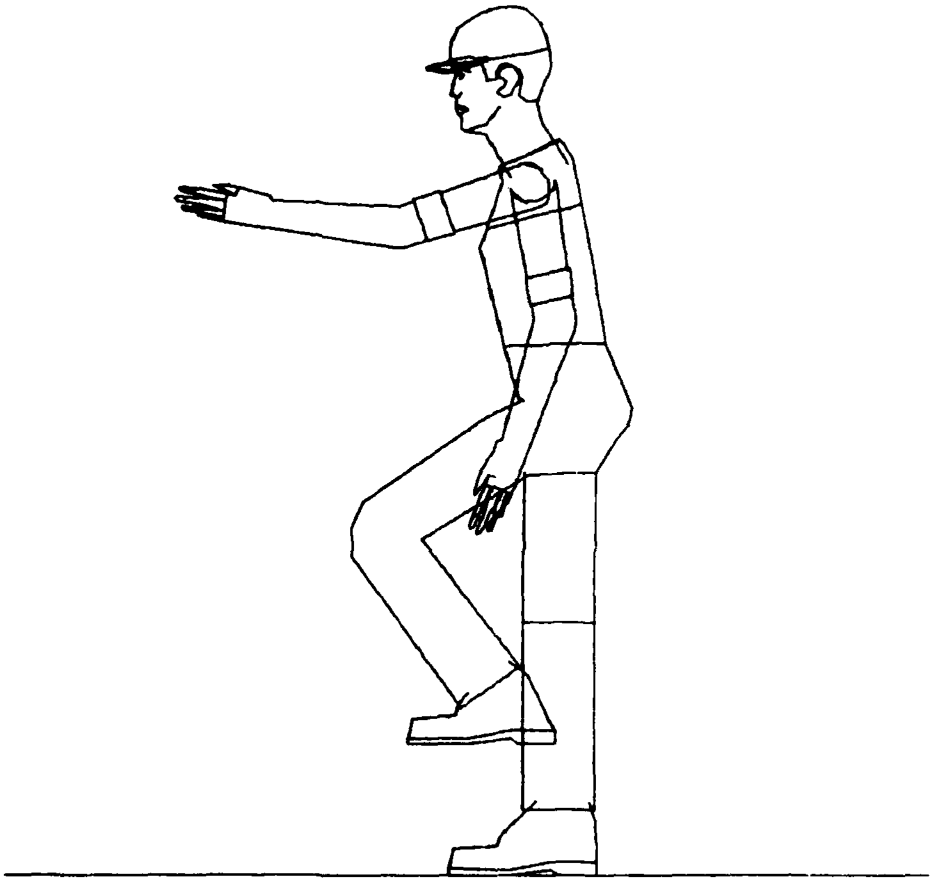


Figure C.12. Initial Climb Posture, with Position Reference Point on Platform and Centered Between the Feet.

APPENDIX D

HAND TOOLS IN CREW CHIEF

APPENDIX D

HAND TOOLS IN CREW CHIEF

D.1 INTRODUCTION

Hand tools commonly used in aircraft maintenance have been included in CREW CHIEF. Evaluations using tools include accessibility (reach interference, work envelope, and visibility) and strength (torque). All tools included in the program are standard tools. Standard tools are defined in MIL-STD 1472C (Reference C.1) as tools (normally hand tools) used for the assembly, disassembly, inspection, servicing, repair, and maintenance of equipment, and which are manufactured by two or more recognized tool manufacturing companies and listed in those companies' catalogs. The appropriateness of the list of tools was verified through interviews with aircraft maintenance managers and technicians at several operational Air Force Bases. Sizing of the tools was based on information in tool catalogs for manufacturers participating in the Air Force warranted tool program.

Tools available for selection are:

ACCESSIBILITY AND TORQUE STRENGTH	
Torque Wrench	Deep Offset Box End
Ratchet Wrench	Ratcheting Box End
Breaker Bar	Open End
Standard Box End	Combination End

Wrenches listed here are shown in Figures D.1 and D.2.

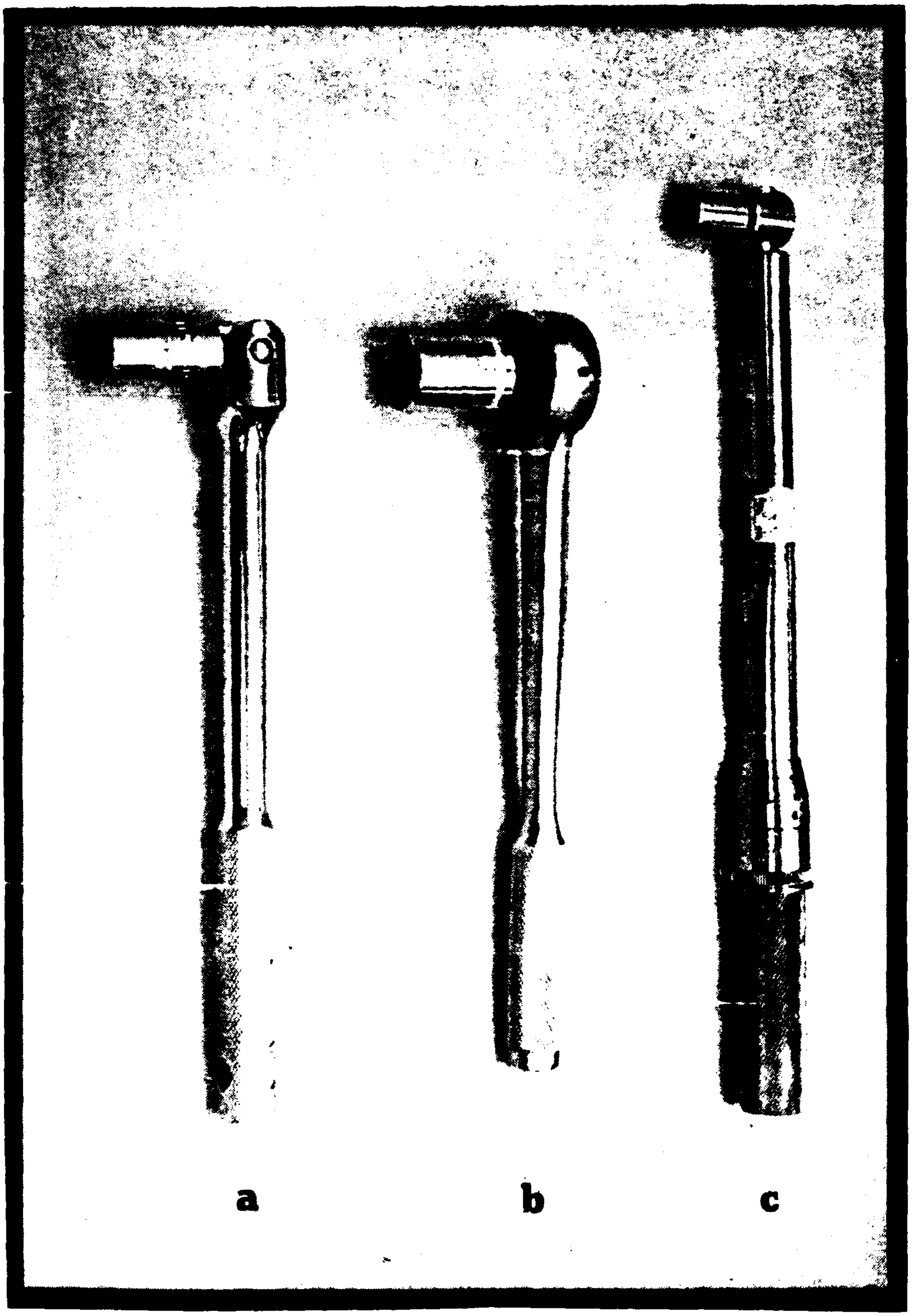


Figure D.1. Socket-Type Wrenches With Strength Analyses Include (a) Breaker Bar, (b) Ratchet Wrench, and (c) Torque Wrench.

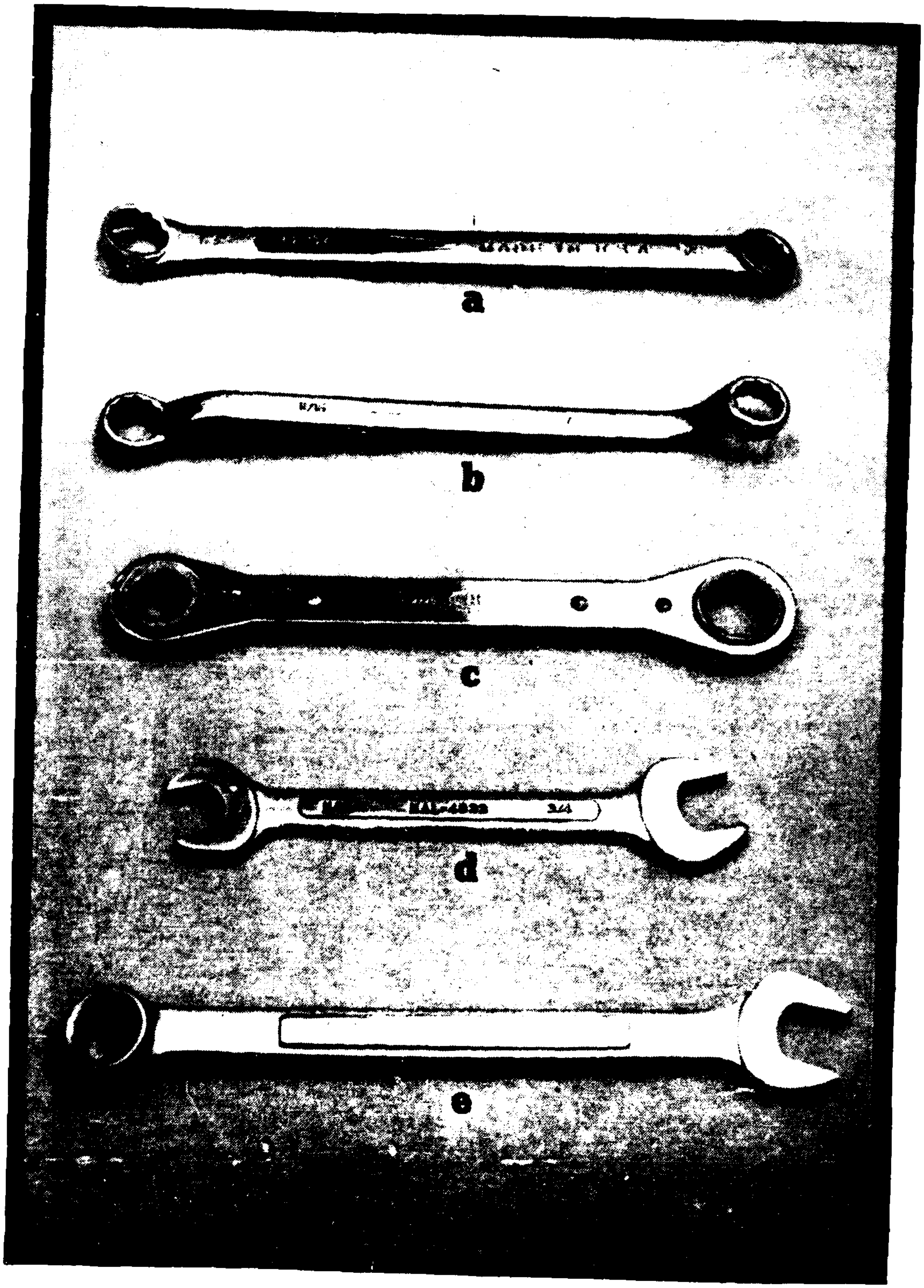


Figure D.2. Common Wrenches With Strength Analyses Include (a) Standard Box End, (b) Deep-Offset Box End, (c) Ratcheting Box End, (d) Open End, and (e) Combination End.

ACCESSIBILITY ONLY

Speed Handle	Hammer with Chisel
Allen Wrench	File
Pliers	Scraper
Screwdriver	Hacksaw
Nutdriver	Power Drill
Hammer	Power Sander

The tools listed here are illustrated in Figures D.3, D.4, D.5, D.6, D.7, and D.8.

D.1.1 WRENCHES

There is a direct relationship between bolt shank diameter and bolt head size. The table below indicates this relationship. Bolts with diameters of less than 3/16 inch are referred to as numbered screws. Dimensions are in inches.

NUMBERED SCREWS

Diameter	Head Size
1, 2	1/8
3, 4, 5	3/16
6, 8	1/4
10	5/16

BOLTS

Diameter	Head Size
3/16	3/8
1/4	7/16
5/16	1/2
3/8	9/16
7/16	5/8
1/2	3/4
9/16	13/16
5/8	15/16
3/4	1-1/4
7/8	1-5/16
1	1-1/2

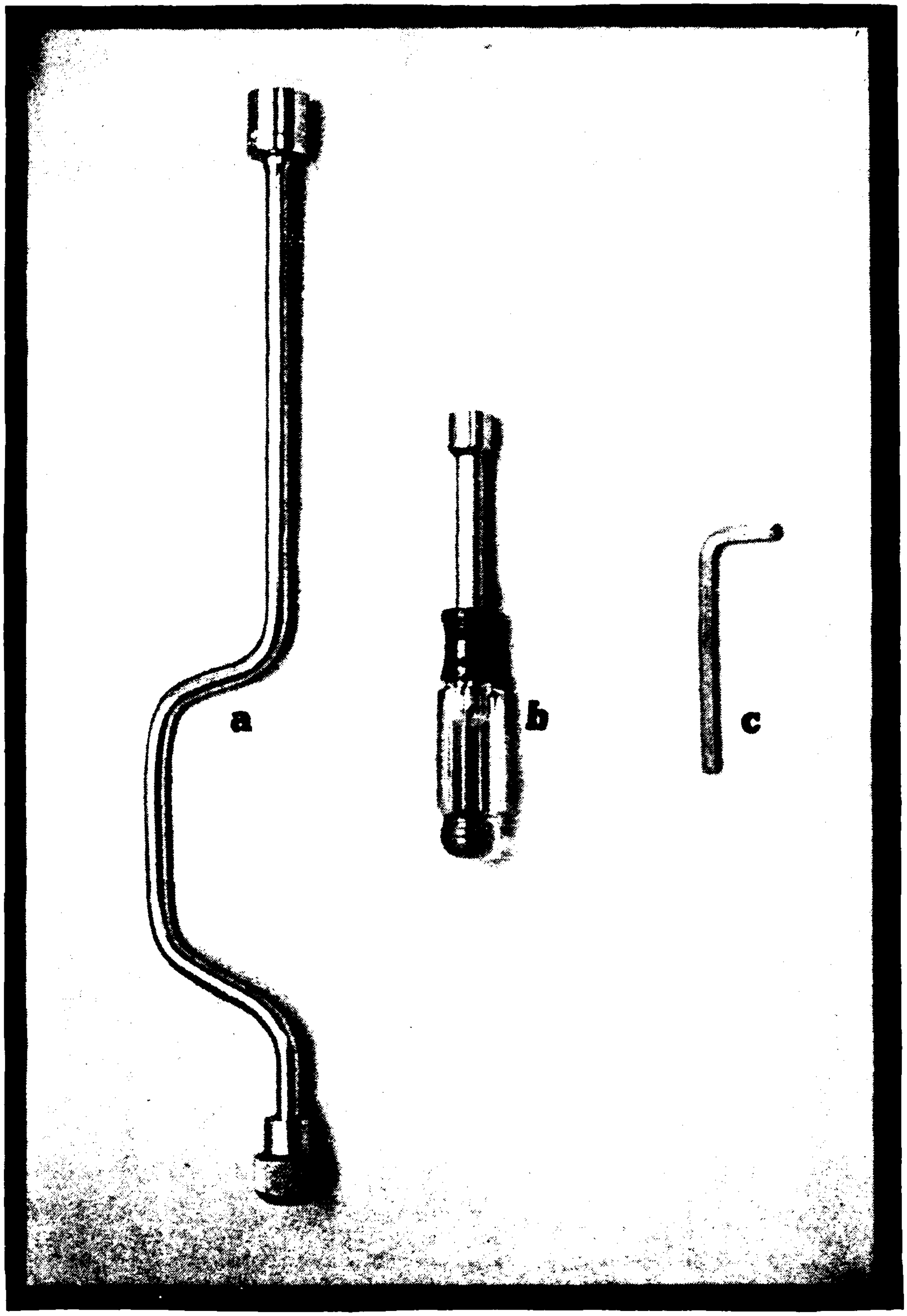


Figure D.3. Wrenches Without Strength Analyses Include (a) Speed Handle, (b) Nutdriver, and (c) Allen Wrench.

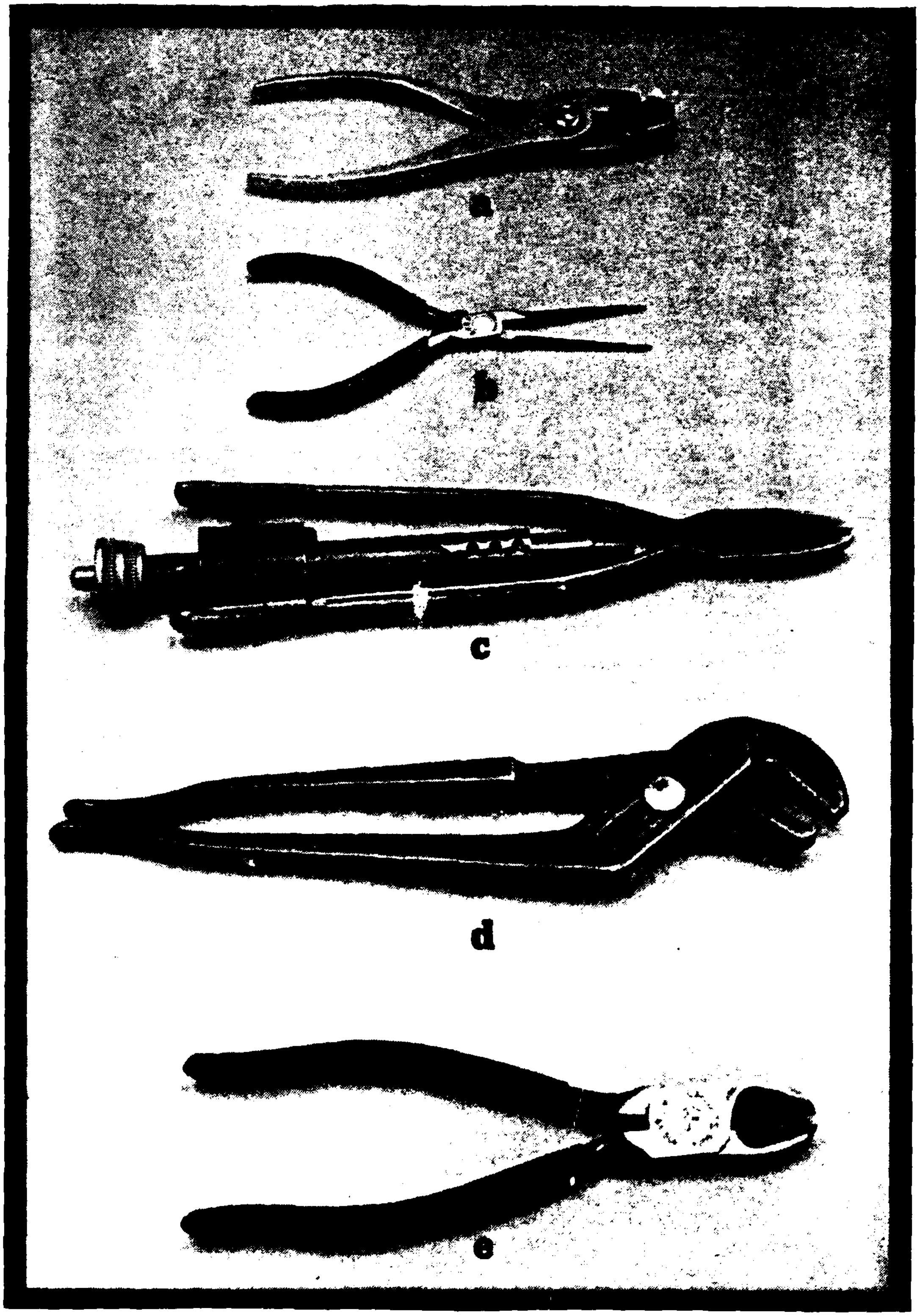


Figure D.4. Plier-Type Tools Include (a) Combination, (b) Needle Nose, (c) Safety Wire, (d) Adjustable Joint, and (e) Wire Cutters.

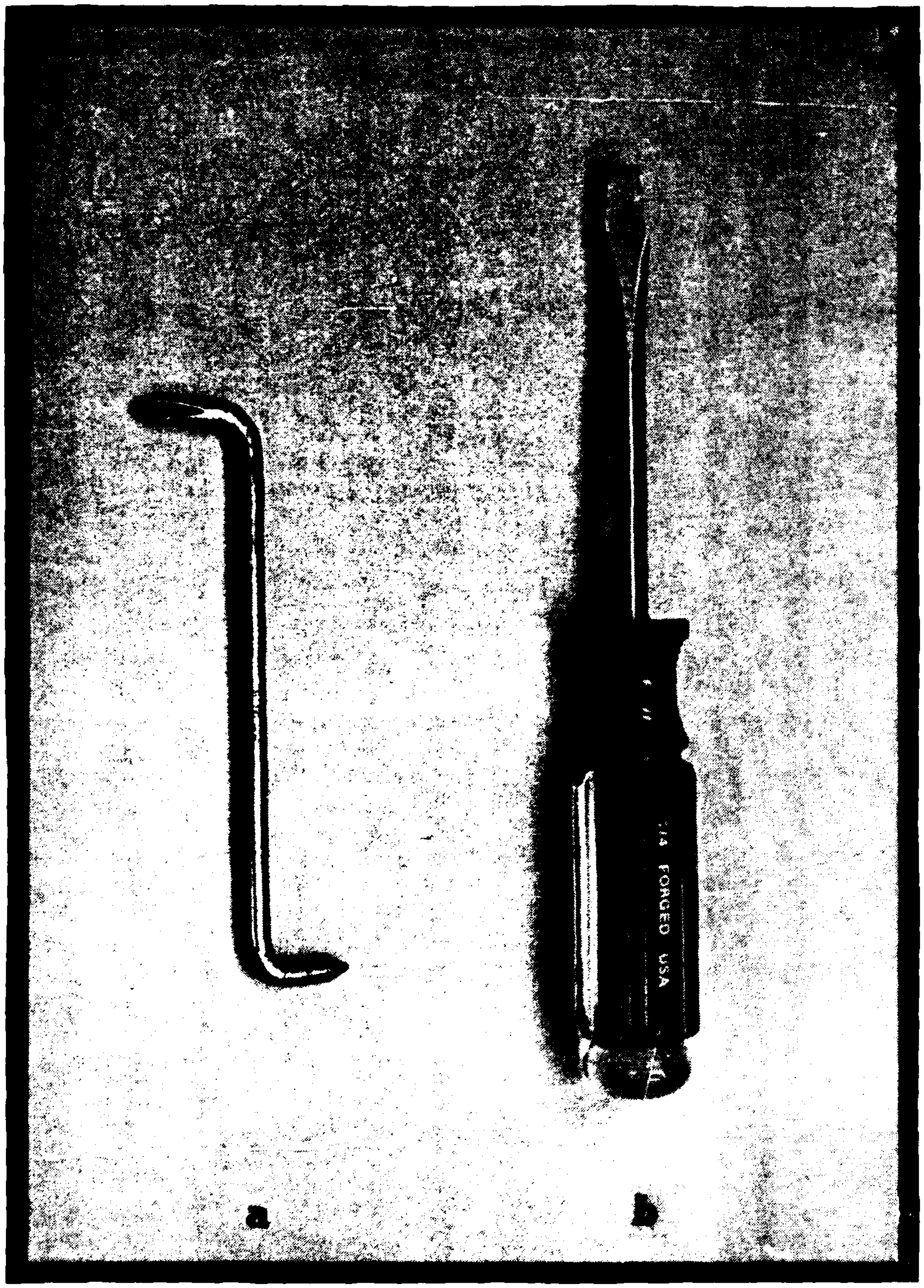


Figure D.5. Screwdrivers Include (a) Offset and (b) Regular.

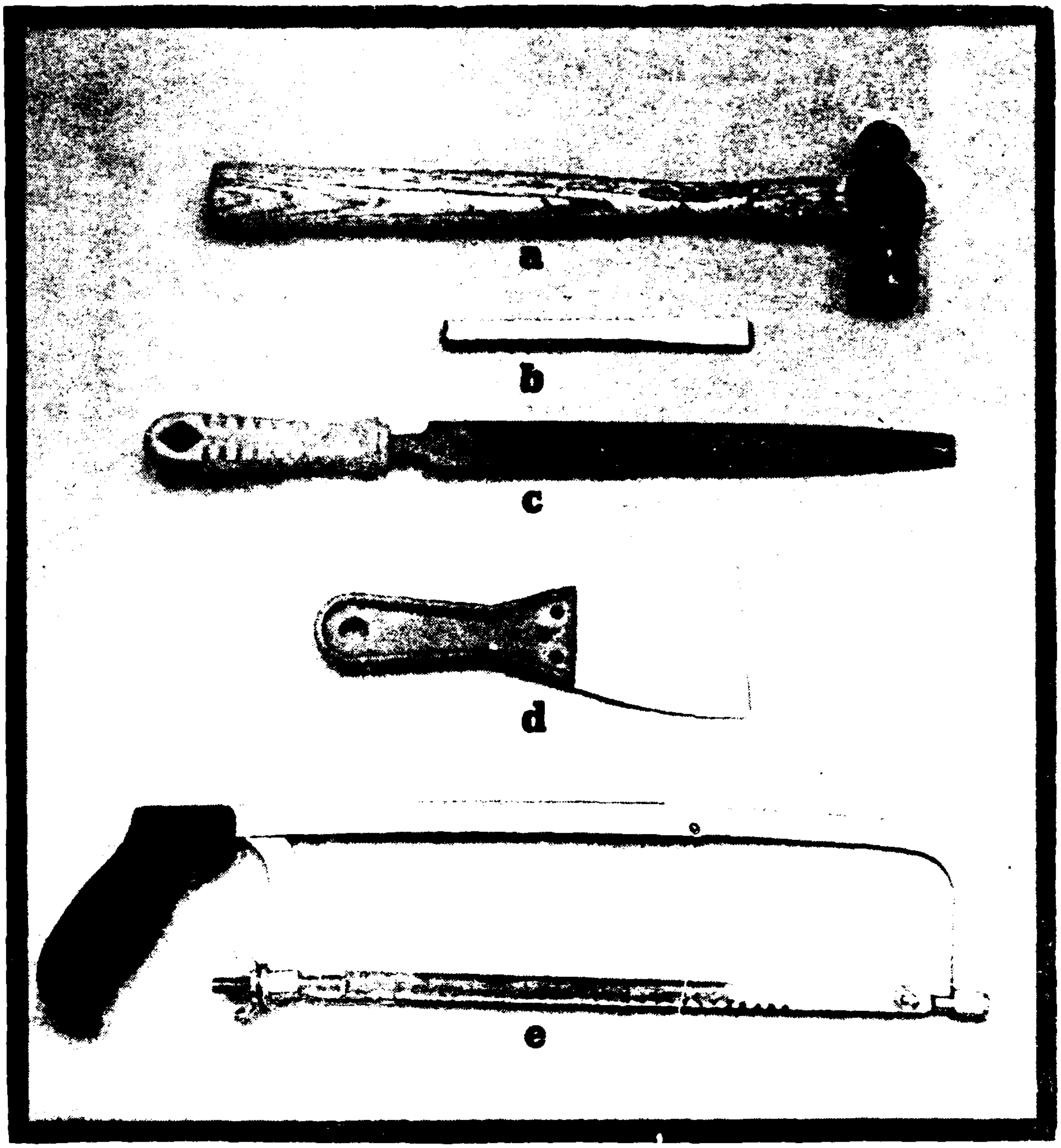


Figure [illegible]. Miscellaneous Tools Include (a) Hammer, (b) Chisel, (c) File, (d) Scraper, and (e) Hacksaw.

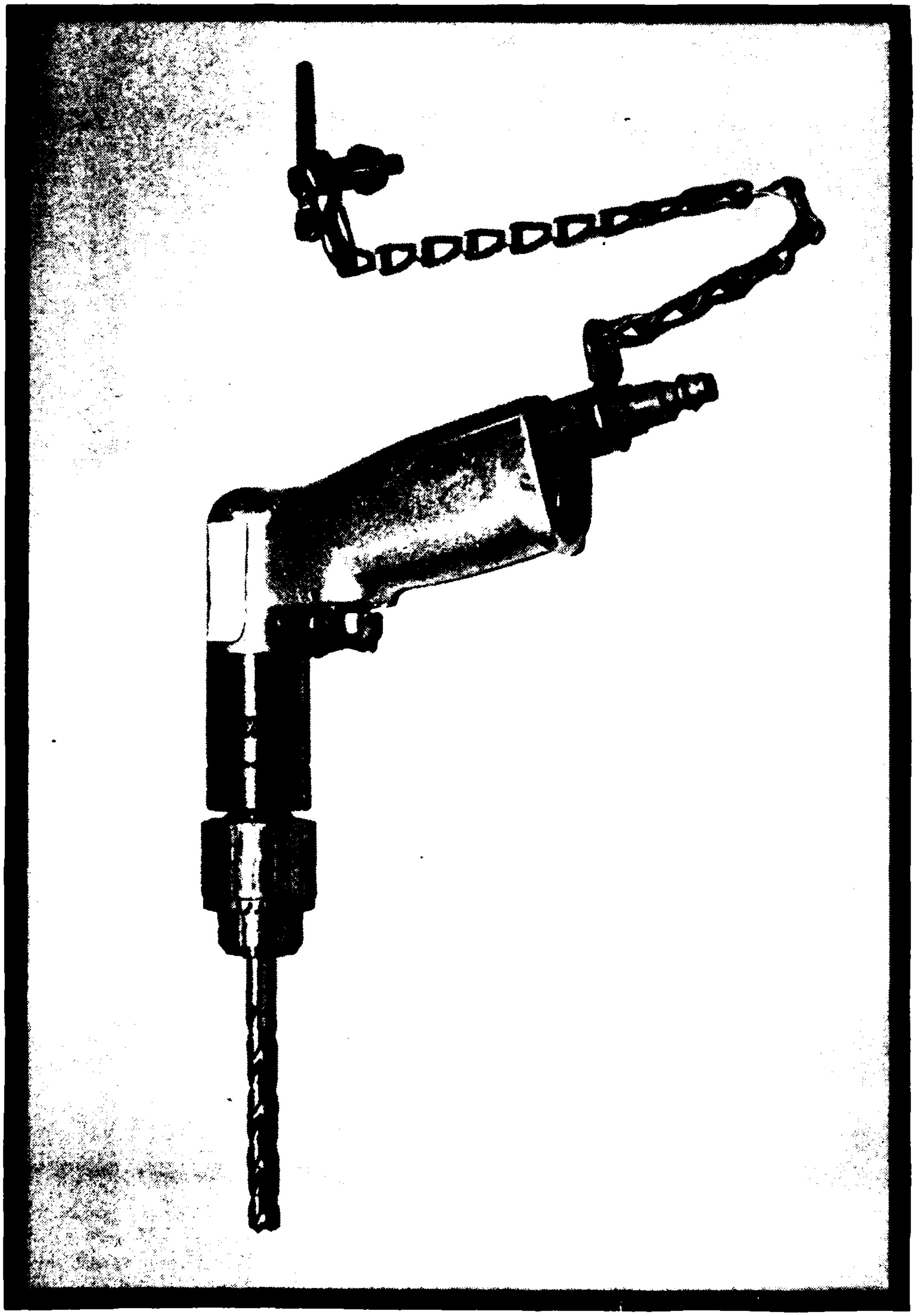
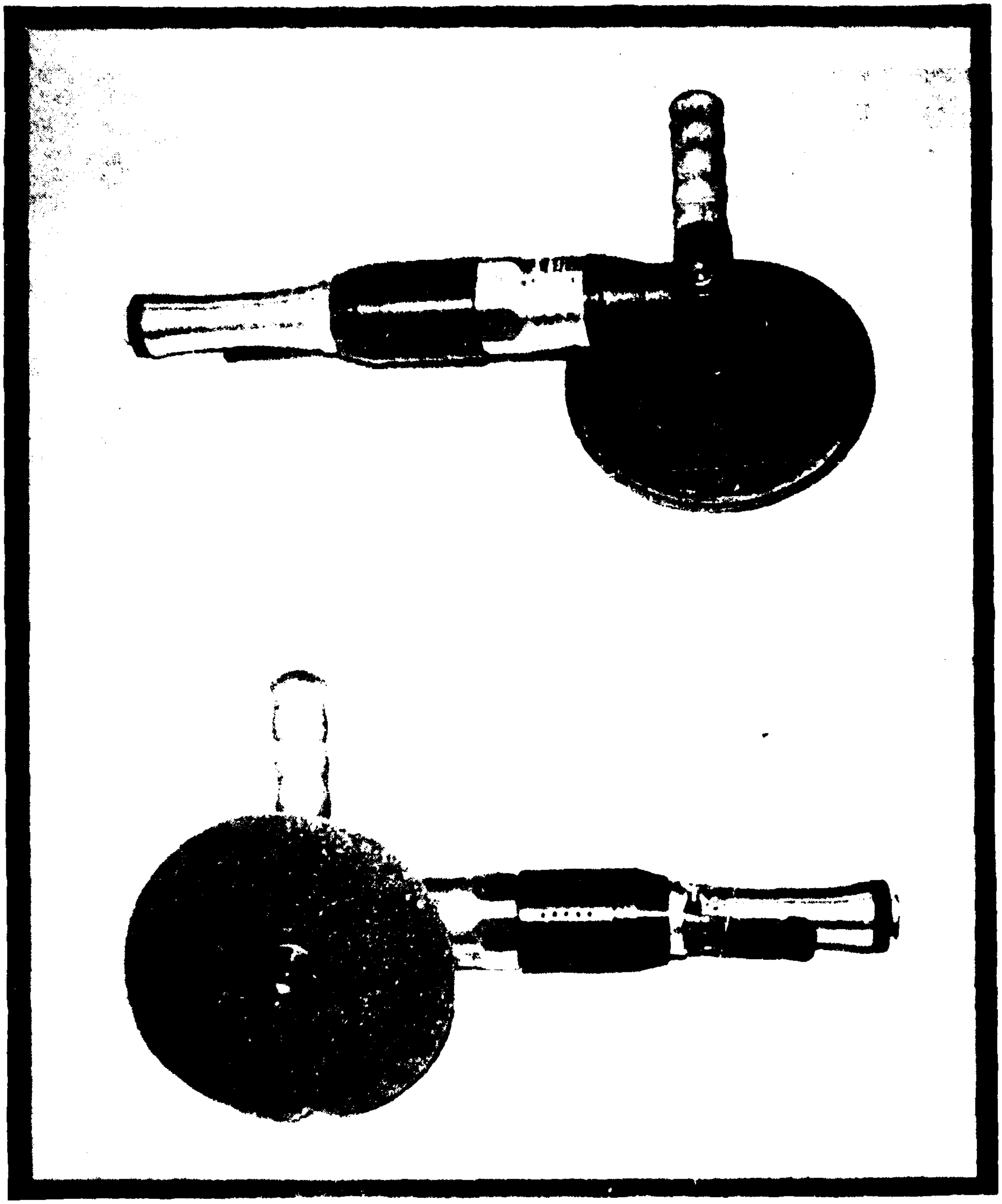


Figure D.7. Power Drill.



In general, the larger the bolt to be turned, the larger the wrench used for the task. For this reason, the wrench sizes in CREW CHIEF are a function of the diameter of the bolt being evaluated.

D.1.1.1 <u>Wrenches with Sockets</u>

For the torque wrench, ratchet wrench, breaker bar, speed handle, and nutdriver (those tools that use sockets) the bolt diameter dictates the tool drive size (1/4, 3/8, or 1/2 inch), and handle lengths in CREW CHIEF correspond to those common for that drive size. Bolt diameters that correspond to each drive size are:

BOLT DIAMETER	DRIVE SIZE
Numbered Screws 1-10	1/4 inch
3/16 to 1/2 inch	3/8 inch
>1/2 inch	1/2 inch

Handle lengths in CREW CHIEF, in inches, are:

	1/4-INCH DRIVE		3/8-INCH DRIVE		1/2-INCH DRIVE	
	Standard	Long	Standard	Long	Standard	Long
Torque Wrench	6.0	9.5	9.5	14.5	20.8	36.0
Ratchet Wrench	5.4	6.5	7.5	10.3	10.3	15.0
Breaker Bar	6.0	9.5	9.5	11.5	15.0	24.0
Speed Handle (Sweep)	3.0	N/A	3.3	N/A	4.1	N/A

D.1.1.1.1 Extensions

Extensions may be used with torque wrenches, ratchet wrenches, and breaker bars to improve accessibility. Extensions of 3, 6, and 12 inches are available in CREW CHIEF. An extension is shown in Figure C.9(a).

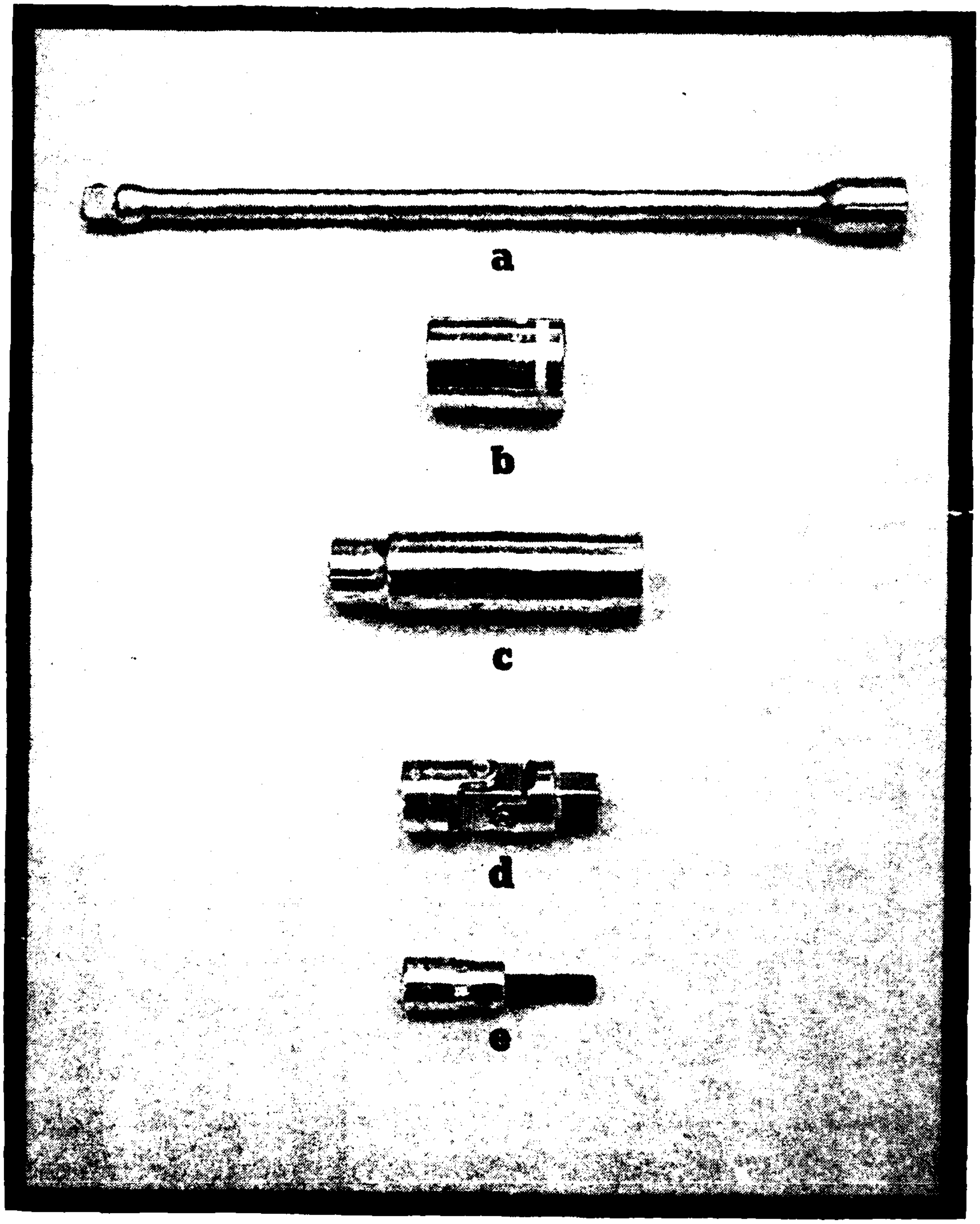


Figure D.9. Extensions and Sockets Include (a) Extension, (b) Regular Socket, (c) Deep Socket, (d) Universal Joint, and (e) Hex Drive.

D.1.1.1.2 Sockets

Four types of sockets are included in CREW CHIEF:

1. Regular
2. Deep
3. Universal
4. Hex Drive.

Sockets are shown in Figure D.9(b-e).

D.1.1.2 <u>Wrenches Without Sockets</u>

Bolt diameter dictates the wrench head size for the standard box end, deep offset box end, ratcheting box end, open end, combination end, allen wrenches, and nutdriver. (The nutdriver in CREW CHIEF is a one-piece tool.) CREW CHIEF automatically selects the handle length appropriate for the wrench head size for the type of wrench selected by the user.

Handle lengths in CREW CHIEF, in inches, are:

STANDARD BOX END

Bolt Diameter	Length
#4, 5,	2.8
#6, 8, 10	3.6
3/16 - 1/4	7.6
5/16 - 3/8	8.8
7/16 - 15/32	10.0
1/2 - 9/16	11.1
19/32 - 5/8	12.8
21/31 - 11/16	13.6
>11/16	16.0

DEEP OFFSET BOX END

Bolt Diameter	Length
#6, 8, 10	4.2
3/16 - 1/4	7.5
5/16 - 3/8	8.5
7/16 - 15/32	9.5
1/2 - 9/16	10.5
19/32 - 5/8	12.2
>5/8	13.1

RATCHETING BOX END

Bolt Diameter	Length
#6, 8, 10	4.3
3/16 - 1/4	5.5
5/16 - 3/8	7.0
7/16 - 15/32	7.0
1/2 - 9/16	7.8
19/32 - 5/8	8.7
21/32 - 11/16	10.0
>11/16	12.8

OPEN END

Bolt Diameter	Length
#4, 5	2.8
#6, 8, 10	4.0
3/16 - 1/4	5.3
5/16 - 3/8	6.5
7/16 - 15/32	7.7
1/2 - 9/16	9.3
19/32 - 5/8	10.8
21/32 - 11/16	11.6
>11/16	13.0

COMBINATION END

Bolt Diameter	Length
#6, 8, 10	4.7
3/16 - 5/16	7.3
3/8 - 7/16	8.3
15/32	9.0
1/2	10.0
9/16 - 19/32	11.3
5/8	13.0
11/16	14.0
>11/16	16.9

ALLEN WRENCH

Bolt Diameter	Short	Long
#1, 2, 3	0.6	1.5
#4 - 10	0.9	2.3
3/16 - 3/8	1.3	3.3
7/16 - 5/8	1.9	4.8
>5/8	2.7	6.8

NUTDRIVER

BOLT DIAMETER	LENGTH
#1-10	6.6
3/16-7/16	7.3

D.1.2 SCREWDRIVERS

Screwdrivers in CREW CHIEF include regular and offset. No distinction is made between standard and crosspoint screwdrivers. Regular screwdrivers are available with the following blade lengths: 1.5, 3, 4, 6, 8, 10 and 12 inches. Two lengths of offset screwdrivers are included: 4.5 and 6 inches.

D.1.3 PLIER-TYPE TOOLS

There are five plier-type tools included in CREW CHIEF:

1. Combination
2. Needle nose
3. Safety wire
4. Adjustable joint
5. Wire cutters.

One size of each of these pliers is included. Therefore, selecting the type of pliers defines the tool size and no other definition is necessary.

D.1.4 MISCELLANEOUS TOOLS

The hammer (ball peen), hammer with chisel, file, scraper, hacksaw, power drill, and power sander are limited to one size each in CREW CHIEF. Therefore, a selection of any of these tools completely defines the tool and no other selections are necessary.

D.2 SELECTING THE PROPER TOOL

When evaluating maintenance tasks that require a tool, the user is faced with choosing the tool that is most appropriate. Often the choice will be evident because the function of the tool is unique in the program, that is, no other tool will do the job. For example, if the task to be evaluated involves determining whether the design provided sufficient space to properly safety-wire an aircraft part, the obvious choice would be the safety wire pliers. At times, however, the choice may not be so clear. A bolt or nut can be torqued with any of several tools included in the program. Likewise, screwdrivers of different lengths may be used with equal success for the same task. The following information and recommendations should make the choice easier.

D.2.1 TOOLS WITH STRENGTH EVALUATION

Strength analyses with tools are available for wrenches only. No other tool strength limitations are considered pertinent to maintainability problems caused by design. Torque capabilities are available with eight of the tool types in CREW CHIEF. These eight tools are used to apply high torque to nuts and bolts.

D.2.1.1 Torque Wrench

The torque wrench must be used when a bolt or nut must be torqued to a specific value dictated by the specific aircraft maintenance technical order. Likewise, this tool is never used if a specific torque value is not required by this technical order. Generally, specific values will be designated if they are critical to safety or proper aircraft operation. Use of a universal joint produces erroneous torques on the bolt, and therefore, the use of the universal is disallowed with the torque wrench.

D.2.1.2 Other Wrenches with Strength Evaluation

The seven other wrenches with strength analyses in the program can be used whenever a specific torque value is not required by the specific aircraft technical order. In these cases, general torque recommendations based on bolt and nut types and sizes can be found in the USAF Technical Order 1-1A-8, "Aircraft and Missile Repair - Structural Hardware" (Reference D.2). These seven wrenches are often chosen by the maintenance technician according to personal preference and/or the tool's accessibility traits in relation to the task. The following is a recommended order of preference for the selection of these seven wrenches.

1. Ratchet
2. Ratcheting box end
3. Breaker bar
4. Combination end
5. Standard box end
6. Deep offset box end
7. Open end (NOTE: It should be obvious that only the open end wrench can be used on tasks involving connections for various lines such as fuel and hydraulic lines.)

D.2.2 TOOLS WITHOUT STRENGTH EVALUATION

D.2.2.1 Wrenches

Three wrenches are included in the CREW CHIEF Program that do not have strength analyses available. Lack of technician's strength while using these tools is not a common maintenance problem.

SPEED HANDLE: As its name implies, the shape of the speed handle allows the technician to turn fasteners at a rapid rate. For this reason, it is used for tasks that require removal or installation of numerous bolts or screws. The prime example is an aircraft access panel that has bolts/screws along its entire perimeter. The speed handle is not useful for applying high torque because of the short moment arm of the sweep.

ALLEN WRENCH: This tool is used on light tasks that require tightening and loosening of internal hex head fasteners. Selection of this tool in the program should be apparent by the task to be evaluated.

NUTDRIVER: This tool is used on small bolts/nuts that are easily turned and especially in recessed areas that do not allow the use of other wrenches. It is commonly used in avionics and electrical system maintenance.

D.2.2.2 Plier-Type Tools

The five types of pliers included in the program combination, needle nose, safety wire, adjustable joint, and

wire cutters) are very common and the appropriate selection of each should be fairly evident to the user based upon the task to be evaluated.

COMBINATION PLIERS: These are the most common pliers. They are used as gripping tools. They should be selected in preference to the other plier-type tools for general gripping tasks. The other four have specific functions and should only be selected if the task corresponds to that specific function.

NEEDLE NOSE PLIERS: These pliers have jaws that are long and slender. They are designed for gripping small objects and for use in areas of restricted access.

ADJUSTABLE JOINT PLIERS: These pliers have jaws that will open wide and are designed for gripping larger objects than can be gripped with the combination pliers. They tend to be large overall and are not useful in areas of limited access.

WIRE CUTTERS: This tool is used only for cutting electrical wire. No other tool in CREW CHIEF should be selected for this function.

SAFETY WIRE PLIERS: This tool has a very specific purpose. It is used only for twisting wire during safety wiring tasks. No other tool should be selected for this task.

D.2.2.3 Screwdrivers

There are two types of screwdrivers in the program: regular and offset. Regular screwdrivers include standard and

crosspoint; that is, no distinction is made in the point types. Regular screwdrivers should be selected in preference to offset screwdrivers. The offset screwdriver is normally used only if necessary because of lack of access with regular screwdrivers. Regular screwdrivers are selected in the program by blade length (1.5, 3, 4, 6, 8, 10, and 12 inches). It is recommended that the user first select the median length (6 inches) as the preferred length and subsequently choose shorter or longer blades as the design dictates.

D.2.2.4 Miscellaneous Tools

All other tools in the CREW CHIEF Program (hammer, hammer with chisel, file, scraper, hacksaw, drill, and sander) have unique functions and their appropriate selection should be evident by the task to be evaluated.

APPENDICES' REFERENCES

A.1 "Human Engineering Design Criteria for Military Systems, Equipment, and Facilities," MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

A.2 Churchill, E., Kikta, P., & Churchill, T., The AMRL Anthropometric Data Bank Library: Vols. I-V, AMRL-TR-77-1, Wright-Patterson Air Force Base, OH: Aerospace Medical Research Laboratory, Aerospace Medical Division, Air Force Systems Command, Oct 1977. (pp. 105-137).

A.3 Churchill, E., et. al, pp. 33-63.

A.4 McDaniel, J.W., Skandis, R.J., & Madole, S.W., Weight Lift Capabilities of Air Force Basic Trainees, AFAMRL-TR-83-0001, Wright-Patterson Air Force Base, OH: Air Force Aerospace Medical Research Laboratory's Workload Ergonomics Branch, Aerospace Medical Division, Air Force Systems Command, May 1983.

A.5 The AFAMRL Anthropometric Data Bank Library: Vol. IX - 1977 Survey of Army Women, Computer Tape AD-A086-302, May 1980.

A.6 Ayoub, M.M., Denardo, J.D., Smith, J.L., Bethea, N.J., Lambert, B.K., Alley, L.R., & Duran, B.S., Establishing Physical Criteria for Assigning Personnel to Air Force Jobs, Lubbock, TX: Institute for Ergonomic Research, Texas Tech University, Sept 1982.

C.1 Human Engineering Design Criteria for Military Systems, Equipment, and Facilities, MIL-STD-1472C, U.S. Government Printing Office: U.S. Air Force, 2 May 1981.

C.2 Aircraft and Missile Repair Structural Hardware, Tech. Order 1-1A-8, U.S. Government Printing Office: U.S. Air Force, 1 Sept 1980.